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Selecting Processes for Automation

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Abstract

With the increasing demand for digitalization, organizations are looking to take advantage of the emerging technologies such as Robotic Process Automation to increase the performance of their business, which makes it essential to identify and select the best cases to automate in order that the compensation of those projects can be beneficial to the organizations.

However, initiating this transition can be difficult without a clear path that the stakeholders need when it comes to selecting the processes that are suitable for automation. Therefore, the objective of this study is to identify a set of criterions to identify the best-suited processes to automate.

To achieve the objective of this research, a Delphi study will be performed so that RPA professionals can evaluate and tune specific criteria to be used to choose business processes to be automated.

According to the Systematic Literature Review performed for this study, only one article presents a 3-step model to select suited business processes for automation. Therefore, this research aims to identify the main criteria evaluated by automation experts to rank business processes suitable for automation.

In this study was possible to collect multiple criterions ranked by RPA experts, which were later used to evaluate business processes in multiple organizations. The results of the evaluation compared the order of development followed by the organization and the order suggested by the were the order of development followed by the organizations matched five times out of six with the order of the evaluation by criteria collected in this study.

Keywords: Robotic Process Automation selection, RPA selection, Robotic Process Automation criteria, RPA criteria.

Resumo

Com o aumento da demanda pela digitalização, as organizações procuram aproveitar as vantagens das tecnologias promissoras como é o caso de Robotic Process Automation de maneira a aumentar o desempenho das suas operações, o que torna importante identificar os melhores casos que possam ser automatizados, isto, para a compensação do desenvolvimento desses projetos beneficie as organizações.

No entanto, iniciar essa transição pode ser difícil sem um caminho claro que as organizações possam começar a realizar a seleção dos processos candidatos a automação. Portanto, o objetivo deste estudo é identificar os principais critérios para avaliar quais são os processos mais adequados para automatizar. Para atingir este objetivo será utilizado um estudo Delphi, onde profissionais com experiência em RPA avaliem uma lista de criterios utilizados na escolha dos processos a serem automatizados.

Neste estudo foi possivel coletar critérios que foram avaliados por especialistas em RPA, critérios esses que foram posteriormente utilizados para avaliar processos em diversas organizações com resultados positivos em que a ordem de desenvolvimento usada pela organização foi a mesma ordem que foi obtida através da avaliação com os critérios recolhidos em 5 dos 6 processos.

Palavras-Chave: Robotic Process Automation selection, RPA selection, Robotic Process Automation criteria, RPA criteria.

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List of Abbreviations and Acronyms

DSR – Design Science Research

RPA – Robotic Process Automation

SLR – Systematic Literature Review

Chapter 1: Introduction

Robotic Process Automation (RPA) has been a topic getting more attention in the past few years, academically and in organizations [9].

Despite the absence of a consensual definition of RPA, there is a common idea that most researchers share, which characterizes RPA as a technology allowing human users to be complete or partially disengaged from business processes that are performed by software robots. These software robots then mimic the actions the same way a human user would do but faster [11] and avoid human error [10].

With the ongoing digitalization done by organizations which results in an increasing number of different processes that are related, it is beneficial to any organization to have these processes all working together for better fluidity of working procedures, and this is where RPA can be a beneficial technology because it can manage all of these processes running with proper data management which results on additional value creation for the organization [9]. This value creation can be monetary gain or savings, higher productivity or better resource utilization, and a stronger market position [3].

For the current state of RPA tools, the software robots cannot yet make decisions for themselves therefore, every automated process should follow some rules like having a standardized with low exceptions, but in the future, with the help of other technologies such as AI and Machine Learning the projects automated though RPA can become capable of automating processes where there is a need of a higher cognitive level, as well as handling more types of exceptions reducing the tasks done IT support teams [11].

In the case of any emerging new technology, there will be many benefits that organizations would like to take advantage of, resulting in new research and developments, such is the case for projects using RPA. Nevertheless, adverse effects are also significant to any organization when considering RPA solutions since they imply significant corporate investments in knowledge, time, and money [7].

Many industries can benefit from RPA. There is evidence in literature Healthcare [6] Banking [7], among others, are now adopting and taking advantage of RPA technology. However, the mindset behind RPA processes is always the same. For example, to find a repetitive business process with a considerable number of transactions to generate the most value to an organization, this value can be monetary [1] or data handling being managed correctly [10].

It would be possible to translate administrative backend processes to software robots making these transactions fully automated, which could help with better data handling and quicker outputs for human workers to help them make faster and more informed decisions [9].

Therefore, it is vital to select the best cases to automate that would bring more value and free time from critical employees, making the development of a selection model much more critical. So, this selection follows specific guidelines and makes the selection process easier and faster.

Therefore, the objective of this study is to identify a set of evaluated criteria to select the best-suited processes to automate.

A Design Science Research (DSR) methodology will be used to develop an artifact to assist managers in selecting processes to be automated. Towards the DSR, a systematic literature review will be performed to elicit the main criteria, then tuned through a fuzzy Delphi with 34 experts.

This research will be structured as follows. Section 2 consists of a Literature Review to assess the models and criteria to evaluate existing business processes in the literature and identify the need for this research. Section 3 contains a DSR where a Delphi study will be used to evaluate the criteria gathered from the Literature Review from Section 2.

Chapter 2: Literature Review

2.1. Background

This section will present the theoretical background related to the present state of RPA in the literature focused on the selection of business processes.

2.1.1. What is RPA

The objective of RPA is to disengage human intervention from repetitive processes and replace them with software robots. With this, more administrative tasks will be taken care of by robots while the employees can focus on demanding cognitive tasks [8]. Furthermore, software robots use the same interfaces that a human does while executing the business process [10], which implies that the flow performed by a software robot is the same that a human would use [10].

Software robots can be split into two categories: unattended and attended. Unattended software robots are categorized as running 24 hours, seven days a week without stopping [3]. Typically, these software robots do not have any human intervention except punctual exceptions, which the software robot cannot solve by himself. They also require inputs with a suitable data structure to properly manage the data and carry with the standard workflow of the everyday transactions of the business process, which helps to reduce exceptions while performing the tasks [11]. On the other hand, unattended projects typically take more time and expertise to develop and bigger development teams due to the hidden complexity that a business process could have, even if the business process seems very simple on the surface [3]. The other type of software robot is attended software robots. These software robots can do the same processes as the unattended ones but work alongside a human. Therefore, they do not run constantly, and they only are used when a human decides that there are transactions that the software robot can perform. As a result, attended robots are faster to develop, and unlike unattended robots, they are commonly cheaper to develop [3].

Depending on the objectives, organizations can target one type or the other or even combine both types. For example, unattended robots are used more for high amounts of transaction processes that have not changed in the last 12 months. On the other hand, attended robots might offer more protection to the organization because a human user will always oversee what the robot is doing [3].

2.1.2. RPA in Practice

With the constant digitalization in organizations, there will be a value creation increase due to the utilization and deployment of RPA tools. In addition, RPA appeared to help organizations automate their processes in a way that is faster and reduces their employees' workload on unnecessary time-consuming tasks [8].

Even though a robot works faster than a human, this is not the only benefit that RPA can offer, and there is an extensive list of advantages that multiple sectors can find beneficial.

Robots work faster and more accurately than a human, and this means that in the same amount of time, a robot will do more work than a human, which will create a more significant gain to the organization.

Robots can work without stopping while a human needs a work schedule and breaks while working, therefore not producing the same as a robot [12].

It will also reduce employees' manual work. This way, the employee can work on other tasks that a robot cannot do or even spend time learning new competencies [7].

Reviewing business processes to automate and automate those processes will help the organization standardize their ways of working, resulting in a better data management procedure between processes, making them more efficient.

Robots will perform the same rules for a business process that removes human error from the transaction flow, which is something a human cannot consistently achieve [4].

Software robots are much faster to develop compared to other IT tools and do not require a big team of specialists to develop them.

RPA can help create new jobs such as robot management. However, even though the robots can work by themselves and handle a few exceptions, it will always be necessary to have a support team to take care of these tools despite being attended or unattended [11].

In any technology exists advantages and disadvantages. Even though the RPA advantages are much more significant and can overshadow the disadvantages, knowing them is still very important when deciding if using RPA is the best approach for a case.

The most significant disadvantage and one of the more brought up in RPA is job loss, which is a valid fear that any organization should consider. However, the job loss that RPA represents can be transformed in new hires because RPA solutions will need constant support from human workers. For example, if the robot cannot handle an exception, a human worker will do that task.

On a more technical side, software robots are only capable of automating rule-based processes because the robots still lack cognitive abilities, which is a topic where Artificial Intelligence and Machine Learning can help and give the software robots some sense of cognitive skill that is currently lacking.

RPA solutions are still a short medium-term solution, and these tools are not yet prepared to work on a business process for the long term. This disadvantage can encourage executives to turn down any RPA solutions because, in the future, they will have to develop a new IT tool despite having RPA solutions working or not [8].

2.1.3. Selecting the Process to Automate

The choice of the best business case to automate can be made in three stages. First, the pre-selection stage, where all the candidate cases are looked at on a high level by an RPA specialist, decides which of the business processes should be dropped or should continue for the next stage [10].

In the pre-selection stage, the more common reasons why a use case might not go forward is if the process has too many exceptions or if the RPA tool itself would have a problem dealing with some part of the workflow that the robot is supposed to do.

On the second stage, the business cases that passed the criteria of the pre-selection stage will be looked at on a more detailed level, where the structure of the input data will be checked to make sure that the inputs have a standardized structure or at least a semi-structured layout [1]. The possible exceptions will be documented as well as the other IT tools necessary to complete the process.

In this stage, it is necessary to involve an RPA specialist and a business process owner that can detail the complete workflow of the use case.

In the third stage, the management will analyze the possible savings with the help of the documentation provided by the RPA specialist to choose the best use case that has a more significant possibility to create value for the organization [10].

Table 3 lists the multi-criteria used to choose the business process to be automated. However, the impact on the business between conditions is not the same, and they are ranked in three states [10]:

- Low: Conditions that have a low impact on the business should not be disregarded just because they are low, even though they do not offer a prominent factor if it is worthy of automating the process or not, checking these conditions might be helpful to understand in the use case is a good option for automatization.

- Medium: For a good RPA candidate, it is unnecessary to meet all of the criteria because the importance of these conditions might differ from process to process, so they should be considered on a case-to-case basis.
- High: Every condition in the High state should be met while selecting the business process. Otherwise, the development of the robot might be much more complicated than it should, and once in a production environment can create exceptions that cannot be handled by the robot or even create security threats for the organization itself.

2.2. Related Work

This section describes the central studies in the literature that relate to the proposed investigation. An SLR was conducted because it allows a demanding literature review.

The structure used to conduct such review followed the guidelines of [47] and [43], which keeps this review scientifically rigorous and transparent, which ultimately improves the literature review [43].

It was followed the approach in Figure 1 to perform the SLR. This approach is composed of three phases that should be done sequentially, and each phase has its steps to achieve results with appropriate quality.

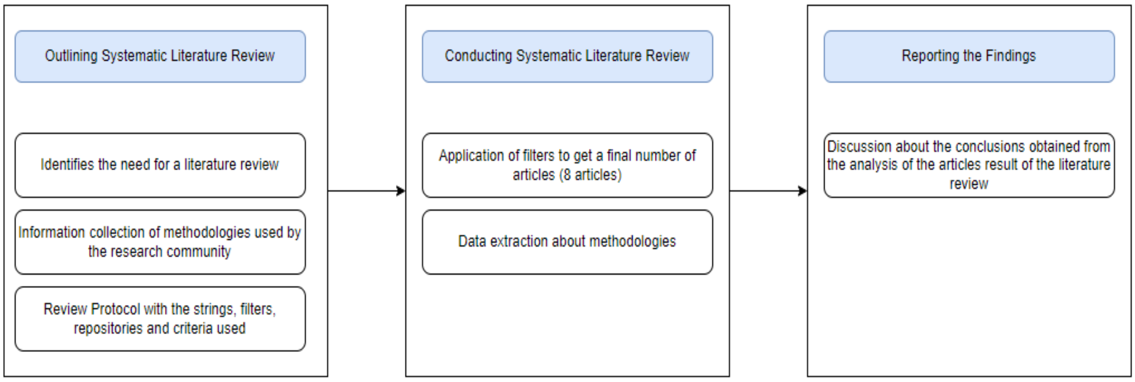

Figure 1. Systematic literature review steps

2.2.1. Outlining systematic literature review

Since this research focuses on identifying the criteria to select the most suitable business processes to automate, this SLR aims to analyze RPA implementations studies that have information regarding the process selection and the criteria used. Then, four electronic repositories were used:

- IEEE
- ACM
- SCHOLAR
- SpringerLink

The exact keywords were used for all the repositories with the operator "AND" and "OR" for this search. The keywords are compiled in the following search string: ("Robotic Process Automation" OR "RPA") "AND" ("selection" or "criteria").

The resulting review only included English articles published in scientific journals or magazines, as well as conferences.

To improve the results of the research conducted, the search string used for each electronic repository varied, intending to adapt the search to the search algorithm used by each repository.

2.2.2. Conducting a systematic literature review

As mentioned in Outlining SLR, the resulting articles needed to pass through two filters, this filtration process is visible in Table 1.

Table 1. Amount Articles resulting of the filtering process

Digital Library	No Filter	First Filter	Second Filter
IEEE	233	1	1
ACM	204	0	0
Scholar	3778	16	6
SpringerLink	9726	4	1
Total	13941	21	8

The first filter had the objective to gather the articles with keywords in the abstract section of the article or in the title to assure that only relevant articles were selected.

The second filter had the aim of removing any duplicate articles, which resulted in eight final articles. The process flow used to filter the articles is visible in Figure 2.

After the conclusion of the filtration process, an analysis of the resulting articles was conducted. The published year, business sector, model type or process criteria, geographical location, and other characteristics were extracted for each article.

The sample is composed of eight articles to understand if there is already any model selection and the criteria used to select business processes. The publication type is visible in Figure 3.

Articles from journals were the main contributor to this research, with a percentage of 62% and an absolute value of five articles. For the articles published in Conferences, the percentage was 38%, with an absolute value of three. In total, eight articles were extracted. Most of the articles collected were published between 2019 and 2020, and only one was published in 2014. Since the result collection of articles gathered from the search was low, the articles were not ranked by any conference or journal ranking mechanism. Therefore, all the articles that passed the filtration process were accepted for the study.

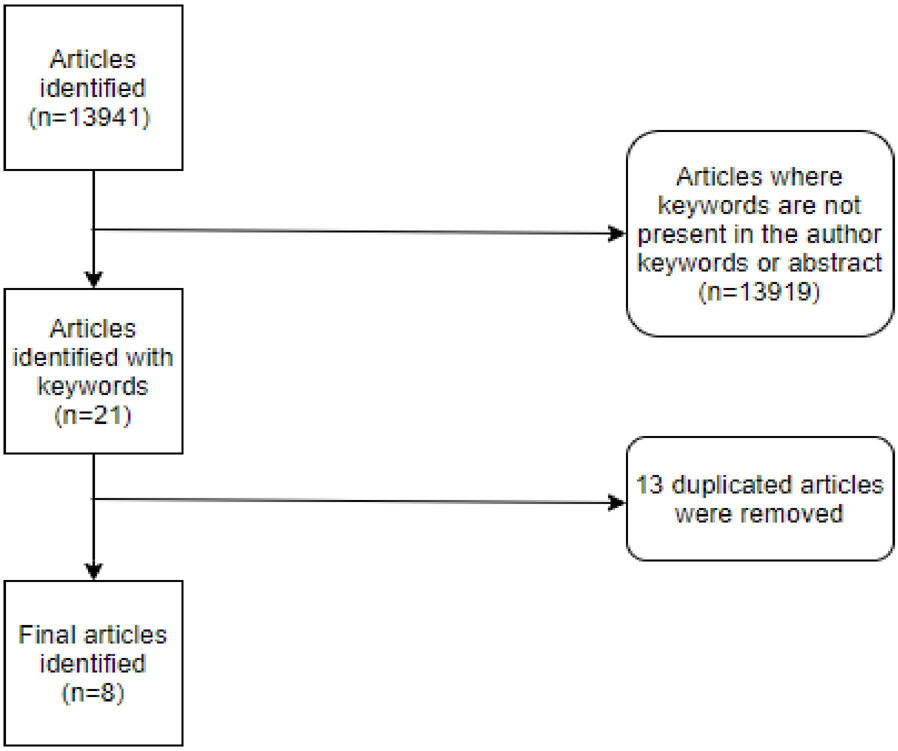

Figure 2. Filtration Flow

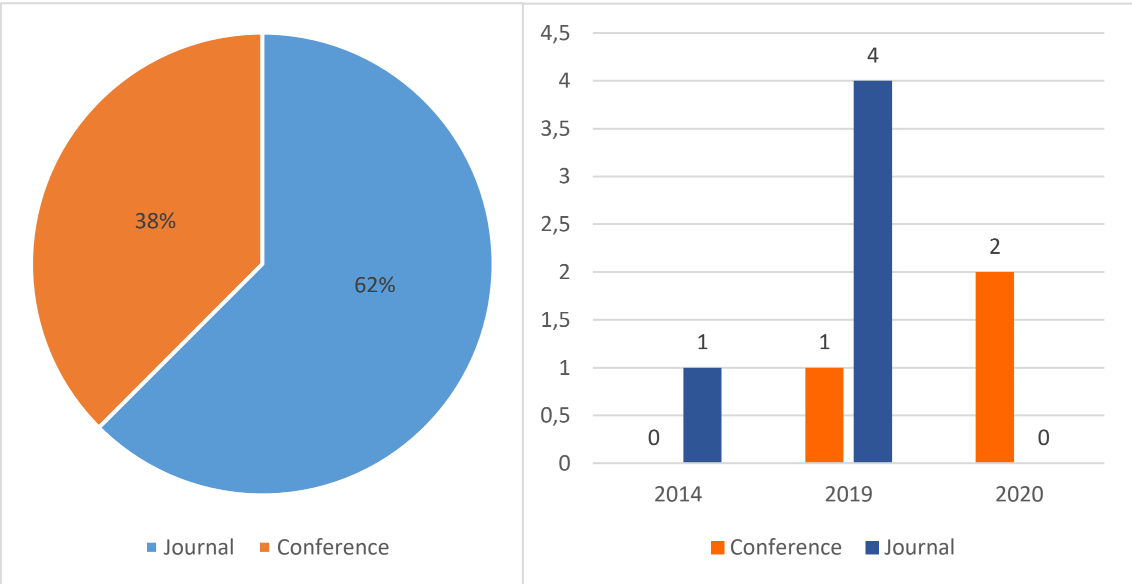

Figure 3. Distribution of publication by type and year

From the final number of articles is visible the lack of literature surrounding the research matter, this can be justified by RPA being a recent technology, or because the developments being done currently do not justify the development of selected models to select the best processes to automate, either because the projects are small, have a low complexity or the push for RPA in the organizations is not substantial.

The analysis of each article is present in Table 2 following the concept theory [46]. In addition, some vectors were used for classification: country and year of the study, if the article provides a model or criteria, and if it is specified any business sector where the criteria mentioned should be used.

Table 2. Extracted articles analysis vectors

Vector / Ref	Country	Provides a model and/or criteria	Year	Specifies the business sector
[1]	Germany	Criteria	2020	No
[3]	Germany	Criteria	2019	No
[4]	Malasya	Criteria	2014	Yes
[5]	Australia, Estonia, Italy	Criteria	2020	No
[7]	India	Criteria	2019	Yes
[8]	Bahrain	Criteria	2019	No
[10]	Germany	Model and Criteria	2019	No
[11]	Portugal	Criteria	2019	No

2.2.3. Reporting the findings

In the systemic literature review conducted, eight articles were identified that provide criteria and models to select processes to automate.

In 2019 the authors [3] gave a small sample of criteria for selecting business processes and characterized the robotic process automation and the ecosystems where software robots can work. However, this small sample of criteria can be upgraded with the findings of other articles such as the case of [1], which provides a long list of conditions and criteria considering different perspectives as well as a few brief examples of criteria evaluation. Same as [5] that focus on control-flow of RPA providing a few examples of criteria that could be used for process selection.

There are also cases where the criteria are dependent on multiple factors such as business department or corporate sector, which can influence the way automation needs to be evaluated, such is the case of the research conducted by the authors [8], that focuses his research in the relationship that RPA can have with the recruitment process in organizations, this way provides a few different criteria related with a specific organization department independent of the business sector, same is the case for the research done by the authors [4] which provides a long list of scenarios where RPA could be beneficial, such security automation and email automation. It also lists criteria, where it mentions thresholds of what can be acceptable to automate a process.

The authors [7] provided an in-depth explanation of RPA. It gives the operations opportunities where RPA can be used, architecture for RPA development, and criteria to select business processes for automation. In this point, it is detailed the evaluation of the criteria with different industries.

In 2019 the authors [11] provided a list of criteria and the relation between those criteria and benefits, disadvantages, possible future challenges, and future opportunities.

From the eight of the articles collected, seven do not provide a selection model, and most articles focus on the criteria that can be used, where the selection of the process that has more value if automated is a job that the management must do based on what criteria and what ranking they give these criteria. Therefore, the selection of the processes does not follow a standard way, and it is instead a case-by-case selection.

Finally, the authors [10] are the only ones out of the eight articles that provide a three-step model to select the best case to automate. The model provided starts with the Pre-selection stage, where an RPA specialist does a high-level overview of the process to understand if the process has any value to automate. The second stage prioritizes the cases that passed the first stage. In this stage, each process has an in-depth evaluation based on criteria tables. In the third and final stage, the management evaluated the cost of the project's development. Only after these three stages are the best cases to automate are decided.

Even though [10] already provides a selection model, it still does not mention if the criteria used on the model are affected by the business sector or the size of the organization. Also, the criteria used in the selection model seem incomplete since the other seven articles provided more criteria than [10].

2.2.4. Related Work Synthesis

It is observed that there are already selection models created to select the best case to automate in the literature. However, they are incomplete because these models do not provide a clear and in-depth list of criteria that should be used. They do not clearly explain how to rank each criterion to the process, department, or business sector. Finally, it is not mentioned if these models are applicable for all the business sectors or if the evaluation of criteria will be different for a different sector. Therefore, a gap exists, and this investigation intends to increase the body of knowledge by identifying a more extensive list of criteria and aims to understand how the different business sectors and sizes of the organizations can use each criterion.

Table 3. Business and Technical Criteria for business process selection

Condition	Definition	Impact	Ref
Amount of human intervention	Relates to the amount of work done by a human while doing this process	Low	[10], [11]
Data structure of inputs	The structure of the data used as inputs should be standardize and semi structured	High	[10], [1], [11]
Process is rule-based	Relates if the business process is based on rules or not, in the case it is not, the use case is not a good process to automate, although AI and machine learning can help in opening opportunities in these cases.	High	[10], [1], [3], [11]
Environments	Relates to the number and which environments are used in the use case and which will be used by the robot.	Low	[10], [11]
Standardized process	The process should already standardize, otherwise the development will take a lot longer and the robot will face a bigger number of exceptions which were not mention while in the development	High	[10], [1], [3], [11]
Process suffered changes on the last 12-18 months	Relates to the stabilization of the business process itself, in the case the process that is meant to be automated did not suffer any major change in the past 12 to 18 months is a good factor to proceed to automate the business process	Low	[11]
Number of exceptions	Any business process with high amounts, and a big diversity of exceptions is not a good candidate to automation	Low	[10], [1], [11]
Business process originates high business value?	Even if a business process does not originate many transactions, the low number of transactions can bring a high business value which makes the business process a contender for automation	High	[1]
Number of transactions	Processes which originate high amounts of transactions are good candidates	High	[1], [11]
None or low cognitive capabilities	Business Processes should have a low need of cognitive capabilities	Low	[1], [11]
Repetitive and monotonous workflow	Repetitive processes are generally good options to automation	Medium	[1], [11]
Existing stable environments	Relates to the stability of the environment where the robot will work, typically more important for unattended robots.	Low	[11]
Current process cost	Relates to the cost which management will have to have to develop and maintain these solutions	High	[10]

Chapter 3: Research Methodology

Design Science Research focuses on two main objectives: first, developing an artifact to solve a practical problem in a specific context. Second, to increase the scientific knowledge about the study matter.

The first aspect of the DSR methodology is to identify the problem that the study aims to resolve: understanding which criteria should be used to choose business processes to automate and how these criteria varies between an organization's size and business sector. The output of this DSR is going to be a list of criterions to evaluate a business process.

After the problem is identified, there is a need to create a construct as an input. This construct was the output of the SLR, which contains a list of all the criteria used to evaluate processes to automate. The evaluation of the artifacts and theories which the DSR outputs are a critical part of the DSR [44].

Since other research paradigms do not design or output any artifacts like the DSR, the creation of artifacts becomes much more relevant to the DSR paradigm. Therefore, the evaluation of the DSR becomes a crucial point and requires researchers to demonstrate the quality of their artifacts based on the evaluation's models [45].

According to [45], the DSR methodology should follow a set of guidelines to lower the complexity associated with the nature of the design.

1- Problem Relevance: Definition of the research problem and justify the value of the solution.
2- Research Rigor: Rigorous methods must be applied in the constructing and evaluation of the design artifact.
3- Design as a Search Process: The search for the artifact must utilize available means to reach the research target.
4- Design as an Artifact: The DSR must create a viable artifact.
5- Design Evaluation: The quality of the design must be demonstrated based on evaluation methods.
6- Research Contributions: Provide verifiable contributions in the design artifact, design foundations, and design methodologies.
7- Communication of Research: The DSR must be well presented to the target audiences.

According to [41], the evaluation of the DSR can be mapped to ex-ante vs. ex-post and artificial vs. naturalistic. Ex-ante suggests that the DSR evaluation will evaluate an uninstantiated artifact, therefore faster. However, with a high risk of false positives, the Ex-Post evaluation will evaluate an instantiated artifact that results in a slower evaluation with a low risk of false positives.

For the Naturalistic vs. Artificial, the Naturalistic evaluation can be designed by choosing among different types of metrics, for the artificial evaluation focus on simulates settings.

For this research, the criteria that best describes the DSR objective is the Ex-Ante Naturalistic because these two criteria combined allow the evaluation to be conducted with real users and a real problem such is the case in section 5 where was performed a evaluation of the actual business process for entire organizations.

The artifacts that result from the DSR must be evaluated to understand the performance they may cause in the organizations. In this DSR, the Delphi methodology was the method that better suited the needs of the study. Therefore, the Delphi methodology is going to be used to build the DSR artifact.

Following the DSR Method (Figure 4), the construct for this study will be the list of criteria gathered from the literature review performed in section 2. This construct will be later used in a Delphi Study section 3 and 4 to build a set of criteria to evaluate business processes.

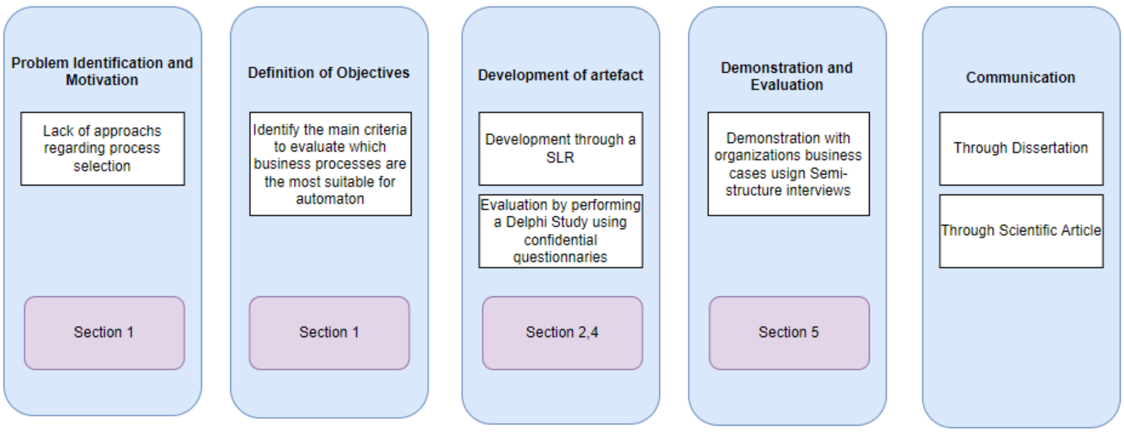

Figure 4. DSR model followed

This set of criteria will be later used in section 5 to evaluate organizational business cases to understand if the output of the Delphi study obtained is helpful in the evaluation and ranking of business processes suitable for automation.

3.1. SLR

To conduct the DSR, the SLR done in Section 2 became a valuable source of literature collection not only because it gathers all the literature referring to a particular research subject. This collection of information allowed the creation of the construct that will be used as an input for the DSR.

The construct created from the SLR gives a view of what can be expected as an artifact for the DSR, which can help manage the Delphi method in the evaluation stage of the DSR.

3.2. The Delphi methodology

The Delphi methods might be characterized as a way of structuring a group communication to allow the participants to deal with the research questions. For this communication to work it is important to gather the feedback of each contributor, assess the group opinion and have anonymity for the participants responses.

The Delphi methodology uses a series of questionnaires with controlled feedback, which avoids confrontation of the participants [36] in a way that every participant can fully express their ideas. Since the questions on a Delphi study questionnaire are intended for a specific group of people that require knowledge on a certain subject, the participants that a Delphi study gather is intended to be a group of experts on the research matter [36] to provide credibility to the artifact.

There is a common issue in the Delphi study related with the attrition of the participants, where exists a big percentage of dropouts on the first round on the questionnaire, which becomes worse in each iteration of the questionnaire [36].

Therefore, it is important for the participants to understand the level of commitment that a Delphi study requires in order that the drop ratio during the study becomes lower.

The Delphi methodology was selected in this research because it was an excellent option to gather accurate information from the experts about the research subject.

The Delphi is developed based on the list criteria mentioned earlier (constructor) as input and follows the flow of the Delphi method in Figure 5.

Delphi aims to create a list of criteria evaluated by RPA experts capable of evaluating the business process to understand if those processes are suitable to be automated.

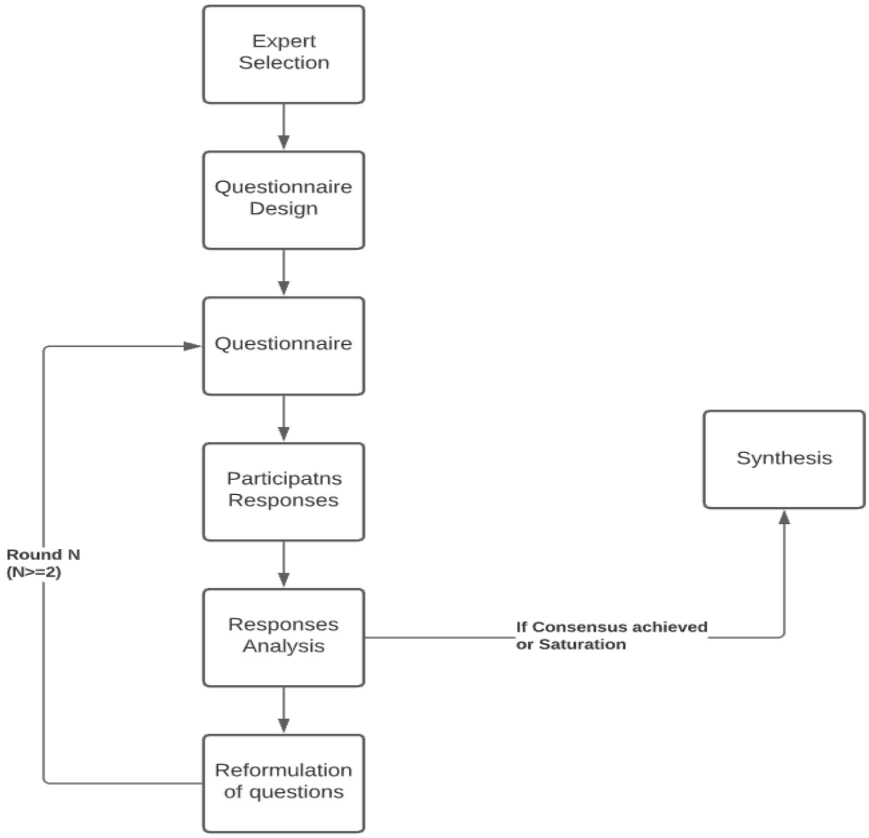

Figure 5. Delphi methodology

3.2.1. Expert Selection

According to [36], which provided a thorough discussion on how experts should be selected to increase rigor in the study. The focus is to identify the kind of expertise required by the participant initiating the study.

In this study, were identified 55 potential participants. These participants were selected based on their expertise on RPA, 34 participants accepted to continue the study.

3.2.2. Communication protocol

The Delphi study requires communication with these experts to be maintained anonymously. Therefore, these invites were made via electronic mail with an overview of the Delphi study and the start date of the first round.

3.2.3. Survey Design

The purpose of this Delphi study is to get the expert panel's consensus on the criteria that should be used to evaluate business processes to automate.

In this Delphi study, the surveys can be divided into two types. The first one used in the first round of the survey was compound by open questions to retrieve order criteria not present on the initial criteria list obtained from the SLR done in Section 2.

The following surveys focused on achieving consensus on the criteria combined from the SLR and the first round of the Delphi study.

3.2.4. Delphi Study instruments validation

An essential process in a Delphi study is the development of instruments, and these instruments can be questionnaires used to collect data on a particular subject matter being investigated. The questionnaires can have one or two questions, so it is possible to understand the general opinion of the participants in the study or multiple questions that the participants need to respond based on their expertise.

The responses from the participants are analyzed at the end of each round. Typically, the first questionnaire is designed with a few questions to give an objective perspective to the researchers for the subsequent questionnaires. From the second questionnaire onwards, the objective is to attain the consensus of the group. The steps for this calculation are demonstrated in Figure 6, [48].

After the analysis of the results of the round, it is necessary to evaluate the next step. If the consensus is not obtained, it must send another questionnaire to verify the participants' opinions again. Although this process can result in multiple rounds, which can cause the drop rate per round to increase, the Delphi study can stop if the consensus is achieved or if the study is at a point of saturation of results.

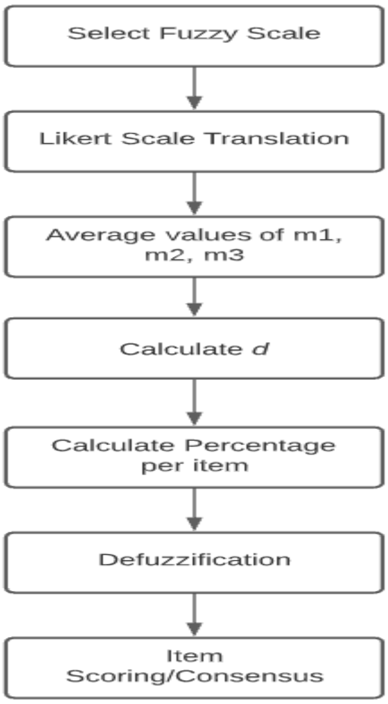

Figure 6. Consensus calculation steps for Fuzzy Delphi

3.2.5. Fuzzy Delphi Methodology

The Delphi methodology helps identify criteria in a set of criteria through questionnaires that collect experts' opinions on a subject matter. However, the calculation of the consensus in the Delphi method can be extensive, especially if there is a big group of experts. Moreover, this calculation happens every round since the opinions of each expert on each item can be different, which results in many rounds, and therefore increase the drop rate of the questionnaires, finally making the result of the Delphi less substantial for the subject matter study [39].

Therefore, it is required to use a method that allows an easier way to handle the consensus between each item and convert the subjective evaluation to a quantitative measure. Based on these requirements, a subset of the Delphi method was used, which is the Fuzzy Delphi Method [40].

There is a significant advantage with the Fuzzy Delphi method when evaluating an extensive set of items. Each item can be evaluated by itself to obtain consensus. Such evaluation can help the researcher discard the item in question to obtain the consensus as intended [37].

Chapter 4: Development of artefact

This section will present the results from the Delphi study for each round, such as the consensus calculation and the steps required to calculate the study consensus. Then, with a set of criteria ranked by the experts, there will be a verification process to understand if the results from Delphi could be used in real cases.

The output from the SLR in section 2 will be used in the second and third rounds of the Delphi study to increase the number of criteria evaluated by the participants and understand which criteria already present in the literature is relevant for this research objectives.

4.1. First Round

The first round of the Delphi study aimed to collect a set of criteria in the form of open questions such as:

"Which is the most important criterion to consider when evaluating business processes for automation, please provide as many criteria as you can"

For the first questionnaire, 34 experts answered, which resulted in a drop rate for that round of 0%. From the unstructured responses of the experts, it was possible to retrieve a list with 33 criterions presented in Table 4. This table showcases the name of the criterion retrieved as well as how many mentions that criterion was obtained from the experts**.**

Table 4. Criterion list obtained from the Delphi study

Bussiness Potential Persective	**Mentions**
Input and Output data	19
Number of exceptions; Savings (time/FTE, money)	17
Repetitive	15
Number of systems involved	14
Accurate process description	9
Systems maturity; Process standardize and stability	8
Volume of items per transaction	7
Process complexity	6
Time consuming; Rule based	5
SLA impact; Number of users; Feasibility; Risk-proneness; Automation type	3
Reusability; Efficiency; Data Security; Manual involvement; No cognitive ability;	2
Labor intensity; Process cost; Similarity between environments; Number of process steps; Process maturity; Applications access; OCR involved; Number of robots that can run at the same time; Test data; Predictability of outcomes; Process Digitalization;	1

4.2. Second Round

From the second round onwards, the objective was to achieve the consensus of the group study. Therefore, a questionnaire was created where the experts evaluated each criterion detailed in Table 4 by a Likert scale with values between 1 and 5. As a result, of the 34 participants in the second round, 31 answered with a drop rate of 8,82%, which respects the 30% drop rate per round stated in literature [37].

The fuzzy Delphi method was used, as mentioned in Section 3. This method facilitates consensus calculation because it can be calculated by item and not by round. Therefore, it was followed a set of specific steps to calculate the consensus, starting with the definition of the Fuzzy scale selection, presented in Table 5, which will be used to translate the Likert values from the questionnaires to values between 0 and 1 to be able to perform all the calculations for the group consensus.

Table 5. Fuzzy Scale selection

Approval level	Fuzzy Scale		
Extremely High (5)	0,6	0,8	1
High (4)	0,4	0,6	0,8
Fair (3)	0,2	0,4	0,6
Low (2)	0	0,2	0,4
Very Low (1)	0	0	0,2

The following step was to calculate the average values of m1, m2, and m3 which represent the minimum (m1) value, the reasonable value (m2) and the maximum value (m3) from the Fuzzy Scale. In this step, the values obtained from the questionnaire between 1 and 5 are translated according to Table 6. Thus, each item from one evaluation will have three different *m* (m1, m2, and m3) values. To calculate the value of the expert agreement level for each item *d* per item the equation (4.1) was used:

$$d = \sqrt{(\frac{1}{3} * (m1 - c1)^2 + (m2 - c2)^2 + (m3 - c3)^2)} \quad (4.1)$$

In the previous equation, the values of m1, m2, and m3 were calculated in the previous step for each item. Thus, the values c1, c2, and c3 are translated from the Likert scale for the fuzzy scale values per item. For this step, the values of *d* per item can be seen in Table 6.

The value of *d* per item and overall to be accepted needs to be ≤0,2 in Table 6. There are only five items that respect this threshold: items 1, 5, 6, 17, and 31.

The value *d* is the average of the values of *d* per item that is ≤0,2, representing a value of *d*=0,171 overall.

Since only five items have values lower than 0,2, the researchers opted by performing another round to reach more consensus.

4.3. Third Round

In the third and final round, the same second-round questionnaire was used to re-evaluate the same set of criteria to achieve better results than in the second round. From 34 participants, only 28 responded to the questionnaire, resulting in a drop rate of 17,65%, which is still lower than the threshold of 30% per round that should be upheld.

This round focused on the re-evaluation of the criteria in round 2, aiming to improve the results of the values for the variable *d* per item. As well as manage it to calculate the consensus for all criteria and create a new set of criteria ranked by the experts' opinions and discard any item which does not respect the thresholds set in the fuzzy Delphi method.

The same equation to calculate the value of *d* per item was the same used in round 2, which resulted in the average values of *d* per item presented in Table 6.

The average values of *d* in round 3 all respected the threshold ≤0,2; therefore, all of them were used to calculate the overall value of d, which is equal to 0,107.

In calculating the percentage per item, the number of times the values *d* per item is ≤0,2 will be divided by the number of participants of each round to get the percentage (Table 6).

For each item to be accepted, the percentage calculated needs to be ≥75%. Otherwise, that item is discarded from the set of items. For example, according to Table 10, from the 33 item percentages calculated, only item 12 did not respect the threshold required. This way, this item was discarded from the criteria pool.

The equation (4.2) allows the calculation of the overall acceptance percentage, all the percentages of the items that respected the threshold of 75% are added and divided by the total number of items minus the discarded items.

$$Overall\ percentage = \frac{sum\ of\ items\ percentage}{total\ number\ of\ items - number\ of\ items\ discarded} \quad (4.2)$$

The minimum value of the threshold for overall percentage is 90%, which was the resulting value from the calculation of the overall percentage from the 32 accepted items.

The process of Defuzzification will determine the position/scoring of each item, which results in calculating the average of the m1, m2, and m3 values. Then, the m1, m2, and m3 values will be used in equation (4.3) to calculate the fuzzy evaluation:

$$fuzzy\ evalution = \left(\frac{1}{3}\right) * (m1average + m2average + m3average) \quad (4.3)$$

According to the values calculated from the equation of the fuzzy evaluation per item, the higher the value, the better position the item will be, presented in Table 6, which indicates that the item had a high level of consensus between the participants. Consequently, it is an important criterion to be included in the set of criteria to analyze possible business processes for automation.

The scoring can be equal for multiple items. For example, items 4 and 26 have an equal score of 5. To determine the scoring item order, it was used the percentage per item demonstrated in Table 6. The item that got a higher percentage would be in a higher position in Table 7. Also, the value α-cut for this calculation was 0,5, which means that any item with a value below 0,5 in the fuzzy evaluation column of Table 7 would also be discarded as it means the experts agree to reject the item from the set of criteria in the study. Based on this threshold value for α-cut, no items were discarded since all the items had fuzzy evaluation values higher than 0,5.

Based on the results of the Delphi method, it was possible to create a new set of criteria, presented in Table 7, where the criteria is ranked based on their scoring value.

Table 6. Criterion consensus calculation for tound 2 and 3

Item	**Round 2**				**Round 3**							
	Average			**Value of *d***	**Average**			**Value of *d***	**Item Number *d* ≤ 0.2**	**Percent of Each Item *d* ≤ 0.2**	**Fuzzy Evaluation**	**Score**
	m1	m2	m3		m1	m2	m3					
1	0,522581	0,722581	0,922581	0,155	0,550000	0,750000	0,950000	0,079	**27**	96%	0,750000	2
2	0,477419	0,683871	0,877419	0,201	0,521429	0,714286	0,921429	0,111	**25**	89%	0,719048	4
3	0,419355	0,619355	0,819355	0,273	0,385714	0,585714	0,785714	0,093	**23**	82%	0,585714	27
4	0,490323	0,690323	0,890323	0,201	0,514286	0,714286	0,914286	0,098	**28**	100%	0,714286	5
5	0,503226	0,703226	0,903226	0,152	0,500000	0,700000	0,900000	0,100	**28**	100%	0,700000	7
6	0,535484	0,735484	0,935484	0,159	0,564286	0,764286	0,964286	0,059	**28**	100%	0,764286	1
7	0,490323	0,690323	0,890323	0,213	0,535714	0,735714	0,935714	0,092	**27**	96%	0,735714	3
8	0,425806	0,625806	0,825806	0,209	0,385714	0,585714	0,785714	0,093	**23**	82%	0,585714	28
9	0,387097	0,587097	0,787097	0,265	0,407143	0,607143	0,807143	0,096	**24**	86%	0,607143	26
10	0,361290	0,554839	0,754839	0,273	0,342857	0,535714	0,735714	0,133	**23**	82%	0,538095	31
11	0,412903	0,606452	0,806452	0,259	0,450000	0,650000	0,850000	0,129	**24**	86%	0,650000	17
12	0,316129	0,509677	0,709677	0,342	0,342857	0,542857	0,742857	0,145	**20**	71%	X	X
13	0,348387	0,535484	0,735484	0,312	0,371429	0,571429	0,771429	0,124	**21**	75%	0,571429	30
14	0,412903	0,606452	0,806452	0,282	0,442857	0,642857	0,842857	0,090	**26**	93%	0,642857	20
15	0,335484	0,529032	0,729032	0,282	0,307143	0,507143	0,707143	0,142	**22**	79%	0,507143	32
16	0,348387	0,535484	0,735484	0,306	0,421429	0,621429	0,821429	0,115	**23**	82%	0,621429	22
17	0,393548	0,593548	0,793548	0,192	0,414286	0,614286	0,814286	0,080	**24**	86%	0,614286	24
18	0,425806	0,625806	0,825806	0,238	0,485714	0,685714	0,885714	0,106	**27**	96%	0,685714	12
19	0,393548	0,593548	0,793548	0,216	0,471429	0,671429	0,871429	0,092	**28**	100%	0,671429	14
20	0,432258	0,632258	0,832258	0,259	0,442857	0,642857	0,842857	0,101	**25**	89%	0,642857	20
21	0,451613	0,651613	0,851613	0,223	0,500000	0,700000	0,900000	0,107	**27**	96%	0,700000	7
22	0,445161	0,645161	0,845161	0,217	0,492857	0,692857	0,892857	0,107	**27**	96%	0,692857	10
23	0,438710	0,638710	0,838710	0,235	0,450000	0,650000	0,850000	0,107	**25**	89%	0,650000	17
24	0,367742	0,561290	0,761290	0,244	0,371429	0,571429	0,771429	0,122	**22**	79%	0,571429	29
25	0,458065	0,658065	0,858065	0,205	0,464286	0,664286	0,864286	0,107	**26**	93%	0,664286	15
26	0,438710	0,632258	0,832258	0,218	0,514286	0,714286	0,914286	0,104	**27**	96%	0,714286	5
27	0,445161	0,645161	0,845161	0,205	0,500000	0,700000	0,900000	0,107	**27**	96%	0,700000	7
28	0,380645	0,574194	0,774194	0,216	0,414286	0,614286	0,814286	0,119	**22**	79%	0,614286	24
29	0,438710	0,638710	0,838710	0,24	0,450000	0,650000	0,850000	0,139	**22**	79%	0,650000	19
30	0,419355	0,619355	0,819355	0,204	0,478571	0,678571	0,878571	0,113	**26**	93%	0,678571	13
31	0,445161	0,645161	0,845161	0,199	0,492857	0,692857	0,892857	0,115	**26**	93%	0,692857	10
32	0,400000	0,593548	0,793548	0,203	0,457143	0,657143	0,857143	0,112	**25**	89%	0,657143	16
33	0,361290	0,541935	0,741935	0,309	0,421429	0,621429	0,821429	0,089	**24**	86%	0,621429	23

Table 7. List of criteria ranked based on experts' opinion

Item number	Item	Fuzzy Evaluation	Score
6	Feasibility	0,764286	1
1	Accurate process description	0,750000	2
7	Input and Output data	0,735714	3
2	Aplications access	0,719048	4
4	Data security	0,714286	5
26	Rule based	0,714286	5
5	Efficiency	0,700000	7
27	Savings	0,700000	7
21	Process maturity	0,700000	7
22	Process standardize and stability	0,692857	10
31	Test data	0,692857	10
18	Process complexity	0,685714	12
30	Systems maturity	0,678571	13
19	Process cost	0,671429	14
25	Risk-proneness	0,664286	15
32	Time consuming	0,657143	16
23	Repetitive	0,650000	17
11	Number of exceptions	0,650000	17
29	SLA impact	0,650000	19
14	Number of systems involved	0,642857	20
20	Process Digitalization	0,642857	20
16	OCR involved	0,621429	22
33	Volume of items per transaction	0,621429	23
17	Predictability of outcomes	0,614286	24
28	Similarity between environments	0,614286	24
9	Manual involvement	0,607143	26
3	Automation type	0,585714	27
8	Labor intensity	0,585714	28
24	Reusability	0,571429	29
13	Number of robots that can run at the same time	0,571429	30
10	No cognitive ability	0,538095	31
15	Number of users	0,507143	32

Chapter 5: Demonstration and evaluation

This section will present the results of the evaluations performed on business processes from different organizations with the criteria list achieved in Section 4.

Based on Table 8, it was possible to perform multiple tests to observe if the ranked list of criteria would satisfy real cases. The ranking of the criteria list was done by three primary thresholds, if the value of *d* per item was below 0,2, if the percentage per item was higher tor equal to 75% and if the fuzzy evaluation value was higher than 0,5. Therefore, six tests were conducted with experts to rank business cases based on the new list of criteria.

In each test, the organizations selected three business processes that could be already automated, in development or to be automated. In the initial phase of the test, the interviewee would give his opinion in which order they would automate the business processes based on their ranking system. Later the experts were asked to evaluate the business processes with values between 1 to 5 based on each criterion listed in Table 7. The experts did not know each criterion's factor values, presented in Table 8, so the evaluation was as unbiased as possible.

As seen in Table 8, the better classified an item was due to the Delphi method, the higher the factor it has. Therefore, the weight of each criterion was calculated by equation (5.1):

$$Score\ per\ item = expert\ value * factor \quad (5.1)$$

$$Factor\ value = \frac{(33 - Item\ position)}{100} \quad (5.2)$$

The equation (5.2) shows how the factor for each item in Table 8 was calculated.

Table 8. Factor values per item

Position	Item	Factor
1	Feasibility	0,32
2	Accurate process description	0,31
3	Input and Output data	0,3
4	Aplications access	0,29
5	Data security	0,28
6	Rule based	0,27
7	Efficiency	0,26
8	Savings	0,25
9	Process maturity	0,24
10	Process standardize and stability	0,23
11	Test data	0,22
12	Process complexity	0,21
13	Systems maturity	0,2
14	Process cost	0,19
15	Risk-proneness	0,18
16	Time consuming	0,17
17	Repetitive	0,16
18	Number of exceptions	0,15
19	SLA impact	0,14
20	Number of systems involved	0,13
21	Process Digitalization	0,12
22	OCR involved	0,11
23	Volume of items per transaction	0,1
24	Predictability of outcomes	0,09
25	Similarity between environments	0,08
26	Manual involvement	0,07
27	Automation type	0,06
28	Labor intensity	0,05
29	Reusability	0,04
30	Number of robots that can run at the same time	0,03
31	No cognitive ability	0,02
32	Number of users	0,01

The interview values were between 1 and 5. The highest this value meant that the criterion for that business process was very relevant, which would increase the final score for that business process. For calculating the score per business process, it was necessary to calculate the average of all the scores per item. The score per business process was a value that only varied between 0 and 1. Closer to 1 would mean that the business process based on the list of criteria used was a good candidate for automation. In Table 9 it is presented the final evaluation of the six tests performed.

Table 9. Test result based on criteria list

Units of analysis	Order by which processes were implemented	Organizational processes assessed			Order advised by the artefact	Match with organization decision?
		Process 1	Process 2	Process 3		
1	1->2->3	0,65687	0,64656	0,53437	1->2->3	✓
2	1->2->3	0,69656	0,73562	0,69687	2->3->1	×
3	3->2->1	0,64812	0,70343	0,71437	3->2->1	✓
4	3->2->1	0,69093	0,69906	0,75281	3->2->1	✓
5	2->1->3	0,65375	0,73031	0,64468	2->1->3	✓
6	2->3->1	0,65968	0,68406	0,67218	2->3->1	✓

As shown in Table 9, from the six tests performed in 5 of the tests, the result order based on the list of criteria matches the same order as the expert would choose to automate the business processes.

Only in the second test the result between the expert order and the list of criteria did not match, resulting in an inconclusive test. In this case, the expert would typically use a small and fixed list of criteria. Only those criteria would matter for their evaluation. From this test, it was even possible to retrieve some feedback from the expert.

This feedback included some key points such as: know who will receive the output of the business process, the urgency of the automation, situations where the automation could potentially replace to be extinct departments and a more significant focus on the calculation of the savings.

Chapter 6: Conclusion

This study presents a criteria list that aims to help evaluate business processes suitable for automation. This research has two main contributions:

- Synthesize the knowledge that already exists in the literature. Such contribution was achieved by performing an SLR, resulting in a compilation set of criteria that served as a basis for the Delphi study.
- Create a set of criteria evaluated by RPA experts. This contribution was achieved by performing a Delphi study which resulted in a set of tuned criteria to produce the final artifact. The proposed artifact was then used to assess a set of processes from real organizations to understand if the result is aligned with workers' decisions.

The findings of this research are in line with the initial questions proposed for this study. This was demonstrated in Section 5 with the positive results obtained from evaluating business processes with the criteria list across multiple organizations.

The issues and limitations encountered in this research can serve as a basis for future developments in the subject matter. The first limitation regards the lack of literature currently available on the matter, which affects the fundamental research since the SLR is the basis for understanding the subject in study, which also affects the rest of the research. The second limitation regards the topic of RPA, in general, being a recent technology. Therefore, it is still challenging to identify people with a high level of expertise on the subject matter, which can cause a broader range of opinions while performing the Delphi study.

Even though the positive results were acquired in this study, there are still some aspects for evaluating business processes that were not considered. Therefore, as future work, the researchers will design a model based on the list of criteria obtained from this study as well as specific points of view given by the interviewees, which are essential to make more conscious decisions and have a more accurate way for evaluation of business processes that have good potential for automation. Furthermore, another future field of study is derived from the progress that RPA might have in the following years, which can acquire a higher level of intelligence from the software through machine learning and artificial intelligence, which can alter the way business processes are evaluated as well as the more significant amount of automation possibilities.

In the Appendix 1 it is possible find the manuscript sent to the Business Process Management Journal as submission for an article.

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Apendix 1

Selecting Processes for Automation

Abstract

With the increasing demand for digitalization, organizations are looking to take advantage of the emerging technologies such as Robotic Process Automation to increase the performance of their business, which makes it essential to identify and select the best cases to automate in order that the compensation of those projects can be beneficial to the organizations.

However, initiating this transition can be difficult without a clear path that the stakeholders need when it comes to selecting the processes that are suitable for automation. Therefore, the objective of this study is to identify a set of criterions to identify the best-suited processes to automate.

To achieve the objective of this research, a Delphi study will be performed so that RPA professionals can evaluate and tune specific criteria to be used to choose business processes to be automated.

According to the Systematic Literature Review performed for this study, only one article presents a 3-step model to select suited business processes for automation. Therefore, this research aims to identify the main criteria evaluated by automation experts to rank business processes suitable for automation.

In this study was possible to collect multiple criterions ranked by RPA experts, which were later used to evaluate business processes in multiple organizations. The results of the evaluation compared the order of development followed by the organization and the order suggested by the were the order of development followed by the organizations matched five times out of six with the order of the evaluation by criteria collected in this study.

Keywords: Robotic Process Automation selection, RPA selection, Robotic Process Automation criteria, RPA criteria.

Chapter 1: Introduction

Robotic Process Automation (RPA) has been a topic getting more attention in the past few years, academically and in organizations [9].

Despite the absence of a consensual definition of RPA, there is a common idea that most researchers share, which characterizes RPA as a technology allowing human users to be complete or partially disengaged from business processes that are performed by software robots. These software robots then mimic the actions the same way a human user would do but faster [11] and avoid human error [10].

With the ongoing digitalization done by organizations which results in an increasing number of different processes that are related, it is beneficial to any organization to have these processes all working together for better fluidity of working procedures, and this is where RPA can be a beneficial technology because it can manage all of these processes running with proper data management which results on additional value creation for the organization [9]. This value creation can be monetary gain or savings, higher productivity or better resource utilization, and a stronger market position [3].

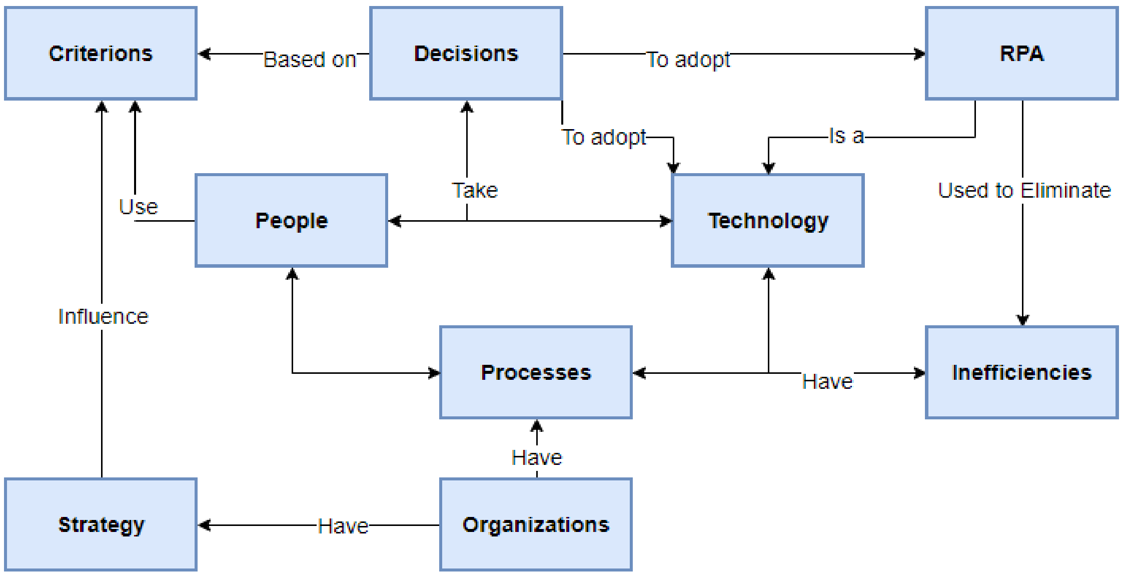
For the current state of RPA tools, the software robots cannot yet make decisions for themselves therefore, every automated process should follow some rules like having a standardized with low exceptions, but in the future, with the help of other technologies such as AI and Machine Learning the projects automated though RPA can become capable of automating processes where there is a need of a higher cognitive level, as well as handling more types of exceptions reducing the tasks done IT support teams [11].

In the case of any emerging new technology, there will be many benefits that organizations would like to take advantage of, resulting in new research and developments, such is the case for projects using RPA. Nevertheless, adverse effects are also significant to any organization when considering RPA solutions since they imply significant corporate investments in knowledge, time, and money [7].

It would be possible to translate administrative backend processes to software robots making these transactions fully automated, which could help with better data handling and quicker outputs for human workers to help them make faster and more informed decisions [9].

Therefore, it is vital to select the best cases to automate that would bring more value and free time from critical employees, making the development of a selection model much more critical. So, this selection follows specific guidelines and makes the selection process easier and faster, in Table 1 it is demonstrated a conceptual map on how the automation of processes are dependent on the criteria used to select these same processes.

Table 1. Conceptual map of the dependence the processes require from criterions.



Therefore, the objective of this study is to identify a set of evaluated criteria to select the best-suited processes to automate.

A Design Science Research (DSR) methodology will be used to develop an artifact to assist managers in selecting processes to be automated. Towards the DSR, a systematic literature review will be performed to elicit the main criteria, then tuned through a fuzzy Delphi with 34 experts.

Chapter 2: Literature Review

2.2. Background

This section will present the theoretical background related to the present state of RPA in the literature focused on the selection of business processes.

2.1.3. What is RPA

The objective of RPA is to disengage human intervention from repetitive processes and replace them with software robots. With this, more administrative tasks will be taken care of by robots while the employees can focus on demanding cognitive tasks [8]. Furthermore, software robots use the same interfaces that a human does while executing the business process [10], which implies that the flow performed by a software robot is the same that a human would use [10].

Software robots can be split into two categories: unattended and attended. Unattended software robots are categorized as running 24 hours, seven days a week without stopping [3]. Typically, these software robots do not have any human intervention except punctual exceptions, which the software robot cannot solve by himself. They also require inputs with a suitable data structure to properly manage the data and carry with the standard workflow of the everyday transactions of the business process, which helps to reduce exceptions while performing the tasks [11]. On the other hand, unattended projects typically take more time and expertise to develop and bigger development teams due to the hidden complexity that a business process could have, even if the business process seems very simple on the surface [3]. The other type of software robot is attended software robots. These software robots can do the same processes as the unattended ones but work alongside a human. Therefore, they do not run constantly, and they only are used when a human decides that there are transactions that the software robot can perform. As a result, attended robots are faster to develop, and unlike unattended robots, they are commonly cheaper to develop [3].

Depending on the objectives, organizations can target one type or the other or even combine both types. For example, unattended robots are used more for high amounts of transaction processes that have not changed in the last 12 months. On the other hand, attended robots might offer more protection to the organization because a human user will always oversee what the robot is doing [3].

2.1.4. RPA in Practice

With the constant digitalization in organizations, there will be a value creation increase due to the utilization and deployment of RPA tools. In addition, RPA appeared to help organizations automate their processes in a way that is faster and reduces their employees' workload on unnecessary time-consuming tasks [8].

Robots can work without stopping while a human needs a work schedule and breaks while working, therefore not producing the same as a robot [12].

It will also reduce employees' manual work. This way, the employee can work on other tasks that a robot cannot do or even spend time learning new competencies [7].

Reviewing business processes to automate and automate those processes will help the organization standardize their ways of working, resulting in a better data management procedure between processes, making them more efficient.

Robots will perform the same rules for a business process that removes human error from the transaction flow, which is something a human cannot consistently achieve [4].

Software robots are much faster to develop compared to other IT tools and do not require a big team of specialists to develop them.

RPA can help create new jobs such as robot management. However, even though the robots can work by themselves and handle a few exceptions, it will always be necessary to have a support team to take care of these tools despite being attended or unattended [11].

In any technology exists advantages and disadvantages. Even though the RPA advantages are much more significant and can overshadow the disadvantages, knowing them is still very important when deciding if using RPA is the best approach for a case.

The most significant disadvantage and one of the more brought up in RPA is job loss, which is a valid fear that any organization should consider. However, the job loss that RPA represents can be transformed in new hires because RPA solutions will need constant support from human workers. For example, if the robot cannot handle an exception, a human worker will do that task.

RPA solutions are still a short medium-term solution, and these tools are not yet prepared to work on a business process for the long term. This disadvantage can encourage executives to turn down any RPA solutions because, in the future, they will have to develop a new IT tool despite having RPA solutions working or not [8].

2.1.3. Selecting the Process to Automate

The choice of the best business case to automate can be made in three stages. First, the pre-selection stage, where all the candidate cases are looked at on a high level by an RPA specialist, decides which of the business processes should be dropped or should continue for the next stage [10].

In the pre-selection stage, the more common reasons why a use case might not go forward is if the process has too many exceptions or if the RPA tool itself would have a problem dealing with some part of the workflow that the robot is supposed to do.

On the second stage, the business cases that passed the criteria of the pre-selection stage will be looked at on a more detailed level, where the structure of the input data will be checked to make sure that the inputs have a standardized structure or at least a semi-structured layout [1]. The possible exceptions will be documented as well as the other IT tools necessary to complete the process.

In this stage, it is necessary to involve an RPA specialist and a business process owner that can detail the complete workflow of the use case.

In the third stage, the management will analyze the possible savings with the help of the documentation provided by the RPA specialist to choose the best use case that has a more significant possibility to create value for the organization [10].

Table 4 lists the multi-criteria used to choose the business process to be automated. However, the impact on the business between conditions is not the same, and they are ranked in three states [10]:

- Low: Conditions that have a low impact on the business should not be disregarded just because they are low, even though they do not offer a prominent factor if it is worthy of automating the process or not, checking these conditions might be helpful to understand in the use case is a good option for automatization.
- Medium: For a good RPA candidate, it is unnecessary to meet all of the criteria because the importance of these conditions might differ from process to process, so they should be considered on a case-to-case basis.
- High: Every condition in the High state should be met while selecting the business process. Otherwise, the development of the robot might be much more complicated than it should, and once in a production environment can create exceptions that cannot be handled by the robot or even create security threats for the organization itself.

2.2. Related Work

This section describes the central studies in the literature that relate to the proposed investigation. An SLR was conducted because it allows a demanding literature review.

The structure used to conduct such review followed the guidelines of [47] and [43], which keeps this review scientifically rigorous and transparent, which ultimately improves the literature review [43].

It was followed the approach in Figure 1 to perform the SLR. This approach is composed of three phases that should be done sequentially, and each phase has its steps to achieve results with appropriate quality.

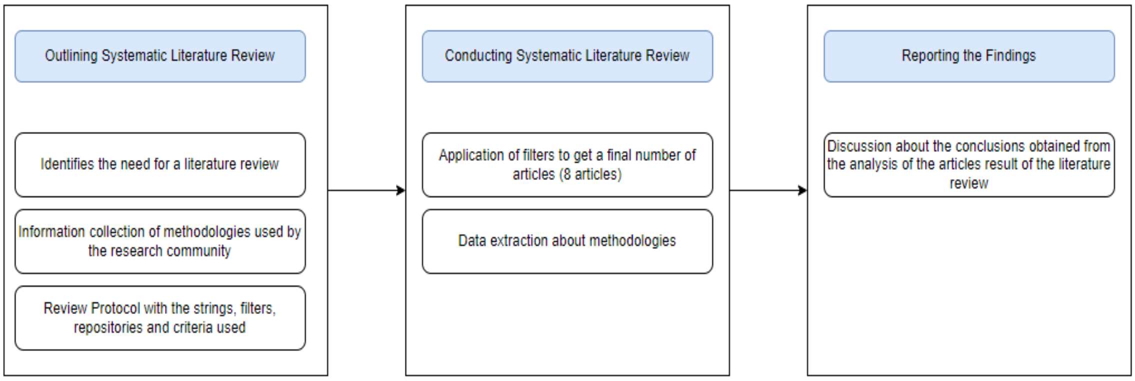


Figure 2. Systematic literature review steps

2.2.1. Outlining systematic literature review

Since this research focuses on identifying the criteria to select the most suitable business processes to automate, this SLR aims to analyze RPA implementations studies that have information regarding the process selection and the criteria used. Then, four electronic repositories were used:

- IEEE
- ACM
- SCHOLAR
- SpringerLink

The exact keywords were used for all the repositories with the operator “AND” and “OR” for this search. The keywords are compiled in the following search string: (“Robotic Process Automation” OR “RPA”) “AND” (“selection” or “criteria”).

The resulting review only included English articles published in scientific journals or magazines, as well as conferences.

To improve the results of the research conducted, the search string used for each electronic repository varied, intending to adapt the search to the search algorithm used by each repository.

2.2.2. Conducting a systematic literature review

As mentioned in Outlining SLR, the resulting articles needed to pass through two filters, this filtration process is visible in Table 2.

Table 2. Amount Articles resulting of the filtering process

Digital Library	**No Filter**	**First Filter**	**Second Filter**
IEEE	233	1	1
ACM	204	0	0
Scholar	3778	16	6
SpringerLink	9726	4	1
Total	13941	21	8

The first filter had the objective to gather the articles with keywords in the abstract section of the article or in the title to assure that only relevant articles were selected.

The second filter had the aim of removing any duplicate articles, which resulted in eight final articles. The process flow used to filter the articles is visible in Figure 2.

After the conclusion of the filtration process, an analysis of the resulting articles was conducted. The published year, business sector, model type or process criteria, geographical location, and other characteristics were extracted for each article.

The sample is composed of eight articles to understand if there is already any model selection and the criteria used to select business processes. The publication type is visible in Figure 3.

Articles from journals were the main contributor to this research, with a percentage of 62% and an absolute value of five articles. For the articles published in Conferences, the percentage was 38%, with an absolute value of three. In total, eight articles were extracted. Most of the articles collected were published between 2019 and 2020, and only one was published in 2014. Since the result collection of articles gathered from the search was low, the articles were not ranked by any conference or journal ranking mechanism. Therefore, all the articles that passed the filtration process were accepted for the study.

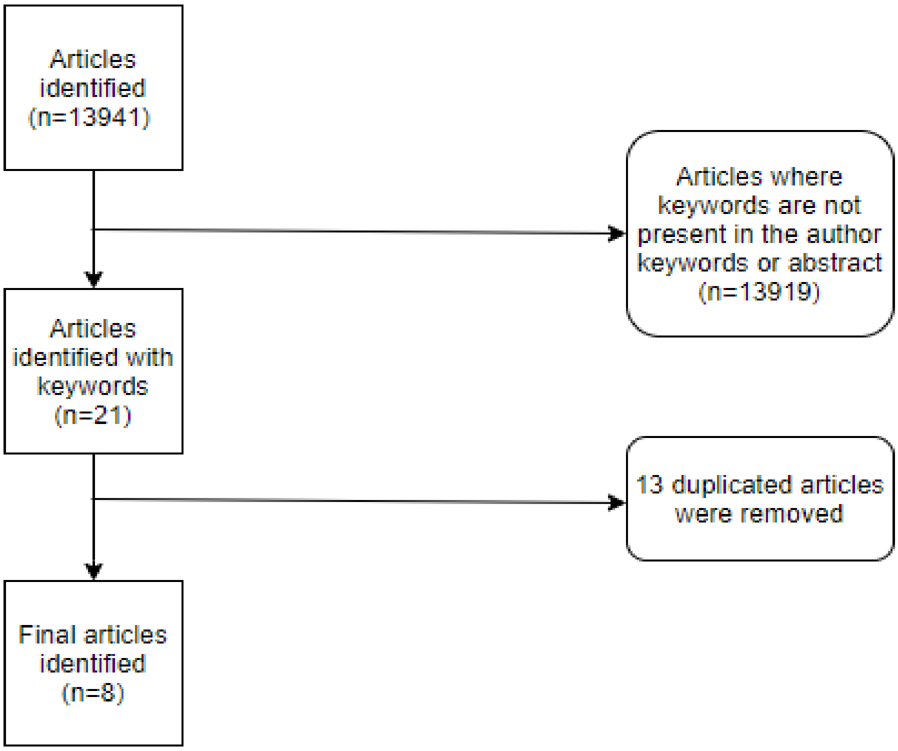


Figure 2. Filtration Flow

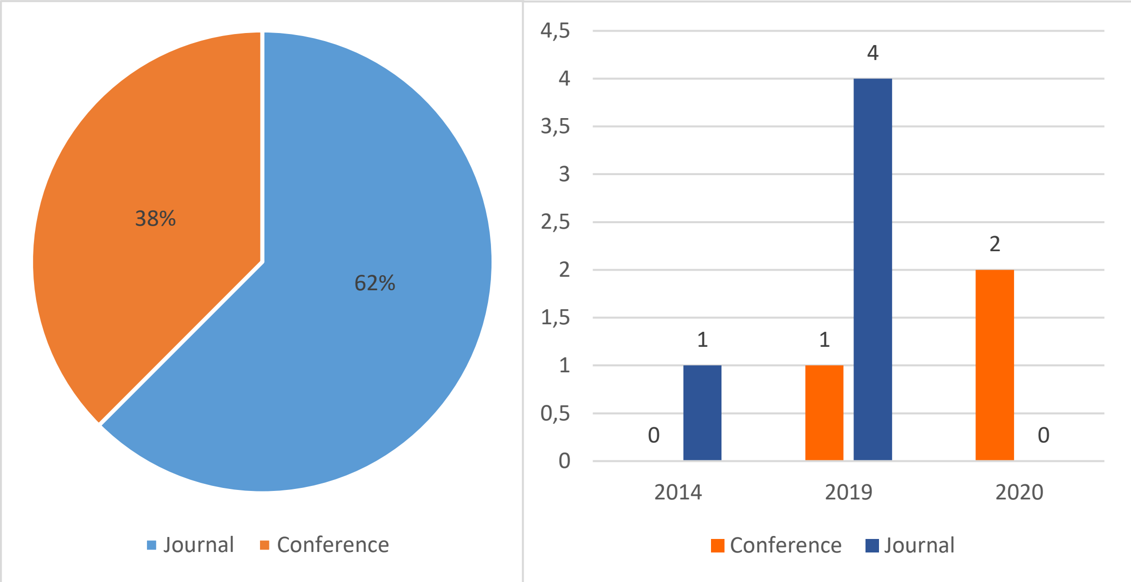


Figure 3. Distribution of publication by type and year

From the final number of articles is visible the lack of literature surrounding the research matter, this can be justified by RPA being a recent technology, or because the developments being done currently do not justify the development of selected models to select the best processes to automate, either because the projects are small, have a low complexity or the push for RPA in the organizations is not substantial.

The analysis of each article is present in Table 3 following the concept theory [46]. In addition, some vectors were used for classification: country and year of the study, if the article provides a model or criteria, and if it is specified any business sector where the criteria mentioned should be used.

Table 3. Extracted articles analysis vectors

Ref \ Vector	Country	Provides a model and/or criteria	Year	Specifies the business sector
[1]	Germany	Criteria	2020	No
[3]	Germany	Criteria	2019	No
[4]	Malasya	Criteria	2014	Yes
[5]	Australia, Estonia, Italy	Criteria	2020	No
[7]	India	Criteria	2019	Yes
[8]	Bahrain	Criteria	2019	No
[10]	Germany	Model and Criteria	2019	No

[11]	Portugal	Criteria	2019	No

2.2.3. Reporting the findings

In the systemic literature review conducted, eight articles were identified that provide criteria and models to select processes to automate.

In 2019 the authors [3] gave a small sample of criteria for selecting business processes and characterized the robotic process automation and the ecosystems where software robots can work. However, this small sample of criteria can be upgraded with the findings of other articles such as the case of [1], which provides a long list of conditions and criteria considering different perspectives as well as a few brief examples of criteria evaluation. Same as [5] that focus on control-flow of RPA providing a few examples of criteria that could be used for process selection.

There are also cases where the criteria are dependent on multiple factors such as business department or corporate sector, which can influence the way automation needs to be evaluated, such is the case of the research conducted by the authors [8], that focuses his research in the relationship that RPA can have with the recruitment process in organizations, this way provides a few different criteria related with a specific organization department independent of the business sector, same is the case for the research done by the authors [4] which provides a long list of scenarios where RPA could be beneficial, such security automation and email automation. It also lists criteria, where it mentions thresholds of what can be acceptable to automate a process.

The authors [7] provided an in-depth explanation of RPA. It gives the operations opportunities where RPA can be used, architecture for RPA development, and criteria to select business processes for automation. In this point, it is detailed the evaluation of the criteria with different industries.

In 2019 the authors [11] provided a list of criteria and the relation between those criteria and benefits, disadvantages, possible future challenges, and future opportunities.

From the eight of the articles collected, seven do not provide a selection model, and most articles focus on the criteria that can be used, where the selection of the process that has more value if automated is a job that the management must do based on what criteria and what ranking they give these criteria. Therefore, the selection of the processes does not follow a standard way, and it is instead a case-by-case selection.

Finally, the authors [10] are the only ones out of the eight articles that provide a three-step model to select the best case to automate. The model provided starts with the Pre-selection stage, where an RPA specialist does a high-level overview of the process to understand if the process has any value to automate. The second stage prioritizes the cases that passed the first stage. In this stage, each process has an in-depth evaluation based on criteria tables. In the third and final stage, the management evaluated the cost of the project's development. Only after these three stages are the best cases to automate are decided.

Even though [10] already provides a selection model, it still does not mention if the criteria used on the model are affected by the business sector or the size of the organization. Also, the criteria used in the selection model seem incomplete since the other seven articles provided more criteria than [10].

2.2.4. Related Work Synthesis

It is observed that there are already selection models created to select the best case to automate in the literature. However, they are incomplete because these models do not provide a clear and in-depth list of criteria that should be used. They do not clearly explain how to rank each criterion to the process, department, or business sector. Finally, it is not mentioned if these models are applicable for all the business sectors or if the evaluation of criteria will be different for a different sector. Therefore, a gap exists, and this investigation intends to increase the body of knowledge by identifying a more extensive list of criteria and aims to understand how the different business sectors and sizes of the organizations can use each criterion.

Table 4. Business and Technical Criteria for business process selection

Condition	Definition	Impact	Ref
Amount of human intervention	Relates to the amount of work done by a human while doing this process	Low	[10], [11]
Data structure of inputs	The structure of the data used as inputs should be standardize and semi structured	High	[10], [1], [11]
Process is rule-based	Relates if the business process is based on rules or not, in the case it is not, the use case is not a good process to automate, although AI and machine learning can help in opening opportunities in these cases.	High	[10], [1], [3], [11]
Environments	Relates to the number and which environments are used in the use case and which will be used by the robot.	Low	[10], [11]
Standardized process	The process should already standardize, otherwise the development will take a lot longer and the robot will face a bigger number of exceptions which were not mention while in the development	High	[10], [1], [3], [11]
Process suffered changes on the last 12-18 months	Relates to the stabilization of the business process itself, in the case the process that is meant to be automated did not suffer any major change in the past 12 to 18 months is a good factor to proceed to automate the business process	Low	[11]
Number of exceptions	Any business process with high amounts, and a big diversity of exceptions is not a good candidate to automation	Low	[10], [1], [11]
Business process originates high business value?	Even if a business process does not originate many transactions, the low number of transactions can bring a high business value which makes the business process a contender for automation	High	[1]
Number of transactions	Processes which originate high amounts of transactions are good candidates	High	[1], [11]
None or low cognitive capabilities	Business Processes should have a low need of cognitive capabilities	Low	[1], [11]
Repetitive and monotonous workflow	Repetitive processes are generally good options to automation	Medium	[1], [11]
Existing stable environments	Relates to the stability of the environment where the robot will work, typically more important for unattended robots.	Low	[11]
Current process cost	Relates to the cost which management will have to have to develop and maintain these solutions	High	[10]

Chapter 3: Research Methodology

Design Science Research focuses on two main objectives: first, developing an artifact to solve a practical problem in a specific context. Second, to increase the scientific knowledge about the study matter.

The first aspect of the DSR methodology is to identify the problem that the study aims to resolve: understanding which criteria should be used to choose business processes to automate and how these criteria vary between an organization's size and business sector. The output of this DSR is going to be a list of criteria to evaluate a business process.

After the problem is identified, there is a need to create a construct as an input. This construct was the output of the SLR, which contains a list of all the criteria used to evaluate processes to automate. The evaluation of the artifacts and theories which the DSR outputs are a critical part of the DSR [44].

Since other research paradigms do not design or output any artifacts like the DSR, the creation of artifacts becomes much more relevant to the DSR paradigm. Therefore, the evaluation of the DSR becomes a crucial point and requires researchers to demonstrate the quality of their artifacts based on the evaluation's models [45].

According to [45], the DSR methodology should follow a set of guidelines to lower the complexity associated with the nature of the design.

8- Problem Relevance: Definition of the research problem and justify the value of the solution.
9- Research Rigor: Rigorous methods must be applied in the construction and evaluation of the design artifact.
10- Design as a Search Process: The search for the artifact must utilize available means to reach the research target.
11- Design as an Artifact: The DSR must create a viable artifact.
12- Design Evaluation: The quality of the design must be demonstrated based on evaluation methods.
13- Research Contributions: Provide verifiable contributions in the design artifact, design foundations, and design methodologies.
14- Communication of Research: The DSR must be well presented to the target audiences.

According to [41], the evaluation of the DSR can be mapped to ex-ante vs. ex-post and artificial vs. naturalistic. Ex-ante suggests that the DSR evaluation will evaluate an uninstantiated artifact, therefore faster. However, with a high risk of false positives, the Ex-Post evaluation will evaluate an instantiated artifact that results in a slower evaluation with a low risk of false positives.

For the Naturalistic vs. Artificial, the Naturalistic evaluation can be designed by choosing among different types of metrics, for the artificial evaluation focus on simulates settings.

For this research, the criteria that best describes the DSR objective is the Ex-Ante Naturalistic because these two criteria combined allow the evaluation to be conducted with real users and a real problem such is the case in section 5 where was performed a evaluation of the actual business process for entire organizations.

The artifacts that result from the DSR must be evaluated to understand the performance they may cause in the organizations. In this DSR, the Delphi methodology was the method that better suited the needs of the study. Therefore, the Delphi methodology is going to be used to build the DSR artifact.

Following the DSR Method (Figure 4), the construct for this study will be the list of criteria gathered from the literature review performed in section 2. This construct will be later used in a Delphi Study section 3 and 4 to build a set of criteria to evaluate business processes.

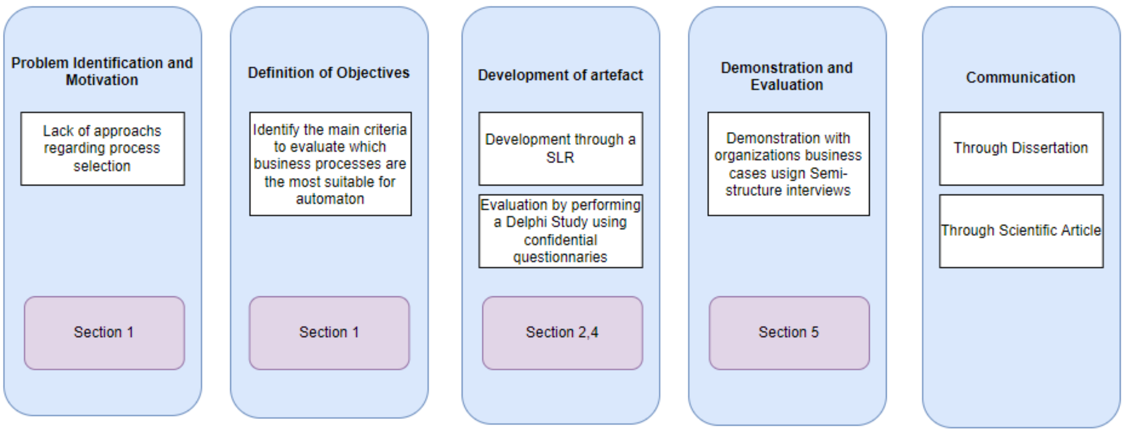


Figure 4. DSR model followed

This set of criteria will be later used in section 5 to evaluate organizational business cases to understand if the output of the Delphi study obtained is helpful in the evaluation and ranking of business processes suitable for automation.

3.1. SLR

To conduct the DSR, the SLR done in Section 2 became a valuable source of literature collection not only because it gathers all the literature referring to a particular research subject. This collection of information allowed the creation of the construct that will be used as an input for the DSR.

The construct created from the SLR gives a view of what can be expected as an artifact for the DSR, which can help manage the Delphi method in the evaluation stage of the DSR.

3.2. The Delphi methodology

The Delphi methods might be characterized as a way of structuring a group communication to allow the participants to deal with the research questions. For this communication to work it is important to gather the feedback of each contributor, assess the group opinion and have anonymity for the participants responses.

The Delphi methodology uses a series of questionnaires with controlled feedback, which avoids confrontation of the participants [36] in a way that every participant can fully express their ideas. Since the questions on a Delphi study questionnaire are intended for a specific group of people that require knowledge on a certain subject, the participants that a Delphi study gather is intended to be a group of experts on the research matter [36] to provide credibility to the artifact.

There is a common issue in the Delphi study related with the attrition of the participants, where exists a big percentage of dropouts on the first round on the questionnaire, which becomes worse in each iteration of the questionnaire [36].

Therefore, it is important for the participants to understand the level of commitment that a Delphi study requires in order that the drop ratio during the study becomes lower.

The Delphi methodology was selected in this research because it was an excellent option to gather accurate information from the experts about the research subject.

The Delphi is developed based on the list criteria mentioned earlier (constructor) as input and follows the flow of the Delphi method in Figure 5.

Delphi aims to create a list of criteria evaluated by RPA experts capable of evaluating the business process to understand if those processes are suitable to be automated.

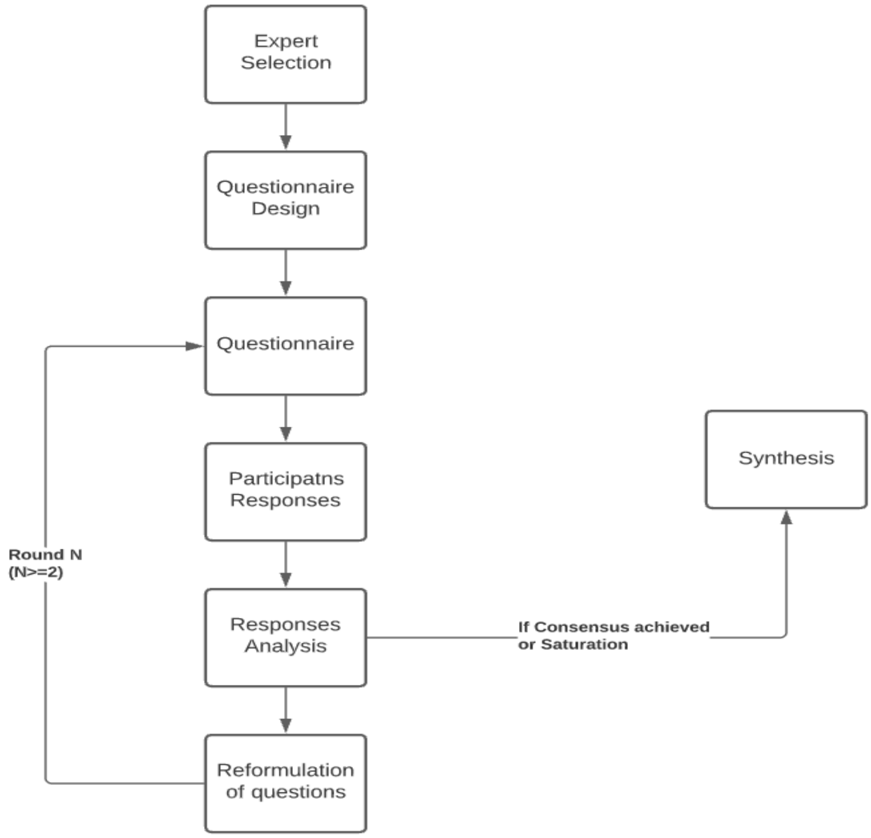


Figure 5. Delphi methodology

3.2.1. Expert Selection

According to [36], which provided a thorough discussion on how experts should be selected to increase rigor in the study. The focus is to identify the kind of expertise required by the participant initiating the study.

In this study, were identified 55 potential participants. These participants were selected based on their expertise on RPA, 34 participants accepted to continue the study.

3.2.2. Communication protocol

The Delphi study requires communication with these experts to be maintained anonymously. Therefore, these invites were made via electronic mail with an overview of the Delphi study and the start date of the first round.

3.2.3. Survey Design

The purpose of this Delphi study is to get the expert panel's consensus on the criteria that should be used to evaluate business processes to automate.

In this Delphi study, the surveys can be divided into two types. The first one used in the first round of the survey was compound by open questions to retrieve order criteria not present on the initial criteria list obtained from the SLR done in Section 2.

3.2.4. Delphi Study instruments validation

An essential process in a Delphi study is the development of instruments, and these instruments can be questionnaires used to collect data on a particular subject matter being investigated. The questionnaires can have one or two questions, so it is possible to understand the general opinion of the participants in the study or multiple questions that the participants need to respond based on their expertise.

The responses from the participants are analyzed at the end of each round. Typically, the first questionnaire is designed with a few questions to give an objective perspective to the researchers for the subsequent questionnaires. From the second questionnaire onwards, the objective is to attain the consensus of the group. The steps for this calculation are demonstrated in Figure 6, [48].

After the analysis of the results of the round, it is necessary to evaluate the next step. If the consensus is not obtained, it must send another questionnaire to verify the participants' opinions again. Although this process can result in multiple rounds, which can cause the drop rate per round to increase, the Delphi study can stop if the consensus is achieved or if the study is at a point of saturation of results.

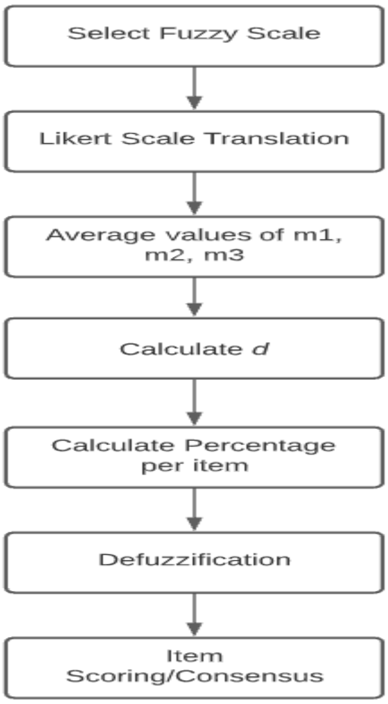


Figure 6. Consensus calculation steps for Fuzzy Delphi

3.2.5. Fuzzy Delphi Methodology

The Delphi methodology helps identify criteria in a set of criteria through questionnaires that collect experts' opinions on a subject matter. However, the calculation of the consensus in the Delphi method can be extensive, especially if there is a big group of experts. Moreover, this calculation happens every round since the opinions of each expert on each item can be different, which results in many rounds, and therefore increase the drop rate of the questionnaires, finally making the result of the Delphi less substantial for the subject matter study [39].

Therefore, it is required to use a method that allows an easier way to handle the consensus between each item and convert the subjective evaluation to a quantitative measure. Based on these requirements, a subset of the Delphi method was used, which is the Fuzzy Delphi Method [40].

There is a significant advantage with the Fuzzy Delphi method when evaluating an extensive set of items. Each item can be evaluated by itself to obtain consensus. Such evaluation can help the researcher discard the item in question to obtain the consensus as intended [37].

Chapter 4: Development of artefact

This section will present the results from the Delphi study for each round, such as the consensus calculation and the steps required to calculate the study consensus. Then, with a set of criteria ranked by the experts, there will be a verification process to understand if the results from Delphi could be used in real cases.

The output from the SLR in section 2 will be used in the second and third rounds of the Delphi study to increase the number of criteria evaluated by the participants and understand which criteria already present in the literature is relevant for this research objectives.

4.1. First Round

The first round of the Delphi study aimed to collect a set of criteria in the form of open questions such as:

"Which is the most important criterion to consider when evaluating business processes for automation, please provide as many criteria as you can"

For the first questionnaire, 34 experts answered, which resulted in a drop rate for that round of 0%. From the unstructured responses of the experts, it was possible to retrieve a list with 33 criterions presented in Table 5. This table showcases the name of the criterion retrieved as well as how many mentions that criterion was obtained from the experts**.**

Table 5. Criterion list obtained from the Delphi study

Bussiness Potential Persective	**Mentions**
Input and Output data	19
Number of exceptions; Savings (time/FTE, money)	17
Repetitive	15
Number of systems involved	14
Accurate process description	9
Systems maturity; Process standardize and stability	8
Volume of items per transaction	7
Process complexity	6
Time consuming; Rule based	5
SLA impact; Number of users; Feasibility; Risk-proneness; Automation type	3
Reusability; Efficiency; Data Security; Manual involvement; No cognitive ability;	2
Labor intensity; Process cost; Similarity between environments; Number of process steps; Process maturity; Applications access; OCR involved; Number of robots that can run at the same time; Test data; Predictability of outcomes; Process Digitalization;	1

4.2. Second Round

From the second round onwards, the objective was to achieve the consensus of the group study. Therefore, a questionnaire was created where the experts evaluated each criterion detailed in Table 5 by a Likert scale with values between 1 and 5. As a result, of the 34 participants in the second round, 31 answered with a drop rate of 8,82%, which respects the 30% drop rate per round stated in literature [37].

The fuzzy Delphi method was used, as mentioned in Section 3. This method facilitates consensus calculation because it can be calculated by item and not by round. Therefore, it was followed a set of specific steps to calculate the consensus, starting with the definition of the Fuzzy scale selection, presented in Table 6, which will be used to translate the Likert values from the questionnaires to values between 0 and 1 to be able to perform all the calculations for the group consensus.

Table 6. Fuzzy Scale selection

Approval level	**Fuzzy Scale**		
Extremely High (5)	0,6	0,8	1
High (4)	0,4	0,6	0,8
Fair (3)	0,2	0,4	0,6
Low (2)	0	0,2	0,4
Very Low (1)	0	0	0,2

The following step was to calculate the average values of m1, m2, and m3 which represent the minimum (m1) value, the reasonable value (m2) and the maximum value (m3) from the Fuzzy Scale. In this step, the values obtained from the questionnaire between 1 and 5 are translated according to Table 7. Thus, each item from one evaluation will have three different *m* (m1, m2, and m3) values. To calculate the value of the expert agreement level for each item *d* per item the equation (4.1) was used:

$$d = \sqrt{\left(\frac{1}{3} * (m1 - c1)^2 + (m2 - c2)^2 + (m3 - c3)^2\right)} \quad (4.1)$$

In the previous equation, the values of m1, m2, and m3 were calculated in the previous step for each item. Thus, the values c1, c2, and c3 are translated from the Likert scale for the fuzzy scale values per item. For this step, the values of *d* per item can be seen in Table 7.

The value of *d* per item and overall to be accepted needs to be ≤0,2 in Table 7. There are only five items that respect this threshold: items 1, 5, 6, 17, and 31.

The value *d* is the average of the values of *d* per item that is ≤0,2, representing a value of *d*=0,171 overall.

Since only five items have values lower than 0,2, the researchers opted by performing another round to reach more consensus.

4.3. Third Round

In the third and final round, the same second-round questionnaire was used to re-evaluate the same set of criteria to achieve better results than in the second round. From 34 participants, only 28 responded to the questionnaire, resulting in a drop rate of 17,65%, which is still lower than the threshold of 30% per round that should be upheld.

This round focused on the re-evaluation of the criteria in round 2, aiming to improve the results of the values for the variable *d* per item. As well as manage it to calculate the consensus for all criteria and create a new set of criteria ranked by the experts' opinions and discard any item which does not respect the thresholds set in the fuzzy Delphi method.

The same equation to calculate the value of *d* per item was the same used in round 2, which resulted in the average values of *d* per item presented in Table 7.

The average values of *d* in round 3 all respected the threshold ≤0,2; therefore, all of them were used to calculate the overall value of d, which is equal to 0,107.

In calculating the percentage per item, the number of times the values *d* per item is ≤0,2 will be divided by the number of participants of each round to get the percentage (Table 7).

For each item to be accepted, the percentage calculated needs to be ≥75%. Otherwise, that item is discarded from the set of items. For example, according to Table 20, from the 33 item percentages calculated, only item 12 did not respect the threshold required. This way, this item was discarded from the criteria pool.

The equation (4.2) allows the calculation of the overall acceptance percentage, all the percentages of the items that respected the threshold of 75% are added and divided by the total number of items minus the discarded items.

$$Overall\ percentage = \frac{sum\ of\ items\ percentage}{total\ number\ of\ items - number\ of\ items\ discarded} \quad (4.2)$$

The minimum value of the threshold for overall percentage is 90%, which was the resulting value from the calculation of the overall percentage from the 32 accepted items.

The process of Defuzzification will determine the position/scoring of each item, which results in calculating the average of the m1, m2, and m3 values. Then, the m1, m2, and m3 values will be used in equation (4.3) to calculate the fuzzy evaluation:

$$fuzzy\ evalution = \left(\frac{1}{3}\right) * (m1average + m2average + m3average) \quad (4.3)$$

According to the values calculated from the equation of the fuzzy evaluation per item, the higher the value, the better position the item will be, presented in Table 7, which indicates that the item had a high level of consensus between the participants. Consequently, it is an important criterion to be included in the set of criteria to analyze possible business processes for automation.

The scoring can be equal for multiple items. For example, items 4 and 26 have an equal score of 5. To determine the scoring item order, it was used the percentage per item demonstrated in Table 7. The item that got a higher percentage would be in a higher position in Table 8. Also, the value α-cut for this calculation was 0,5, which means that any item with a value below 0,5 in the fuzzy evaluation column of Table 8 would also be discarded as it means the experts agree to reject the item from the set of criteria in the study. Based on this threshold value for α-cut, no items were discarded since all the items had fuzzy evaluation values higher than 0,5.

Based on the results of the Delphi method, it was possible to create a new set of criteria, presented in Table 8, where the criteria is ranked based on their scoring value.

Table 7. Criterion consensus calculation for tound 2 and 3

Item	**Round 2**				**Round 3**							
	Average			**Value of *d***	**Average**			**Value of *d***	**Item Number *d* ≤ 0.2**	**Percent of Each Item *d* ≤ 0.2**	**Fuzzy Evaluation**	**Score**
	m1	m2	m3		m1	m2	m3					
1	0,522581	0,722581	0,922581	0,155	0,550000	0,750000	0,950000	0,079	**27**	96%	0,750000	2
2	0,477419	0,683871	0,877419	0,201	0,521429	0,714286	0,921429	0,111	**25**	89%	0,719048	4
3	0,419355	0,619355	0,819355	0,273	0,385714	0,585714	0,785714	0,093	**23**	82%	0,585714	27
4	0,490323	0,690323	0,890323	0,201	0,514286	0,714286	0,914286	0,098	**28**	100%	0,714286	5
5	0,503226	0,703226	0,903226	0,152	0,500000	0,700000	0,900000	0,100	**28**	100%	0,700000	7
6	0,535484	0,735484	0,935484	0,159	0,564286	0,764286	0,964286	0,059	**28**	100%	0,764286	1
7	0,490323	0,690323	0,890323	0,213	0,535714	0,735714	0,935714	0,092	**27**	96%	0,735714	3
8	0,425806	0,625806	0,825806	0,209	0,385714	0,585714	0,785714	0,093	**23**	82%	0,585714	28
9	0,387097	0,587097	0,787097	0,265	0,407143	0,607143	0,807143	0,096	**24**	86%	0,607143	26
10	0,361290	0,554839	0,754839	0,273	0,342857	0,535714	0,735714	0,133	**23**	82%	0,538095	31
11	0,412903	0,606452	0,806452	0,259	0,450000	0,650000	0,850000	0,129	**24**	86%	0,650000	17
12	0,316129	0,509677	0,709677	0,342	0,342857	0,542857	0,742857	0,145	**20**	71%	X	X
13	0,348387	0,535484	0,735484	0,312	0,371429	0,571429	0,771429	0,124	**21**	75%	0,571429	30
14	0,412903	0,606452	0,806452	0,282	0,442857	0,642857	0,842857	0,090	**26**	93%	0,642857	20
15	0,335484	0,529032	0,729032	0,282	0,307143	0,507143	0,707143	0,142	**22**	79%	0,507143	32
16	0,348387	0,535484	0,735484	0,306	0,421429	0,621429	0,821429	0,115	**23**	82%	0,621429	22
17	0,393548	0,593548	0,793548	0,192	0,414286	0,614286	0,814286	0,080	**24**	86%	0,614286	24
18	0,425806	0,625806	0,825806	0,238	0,485714	0,685714	0,885714	0,106	**27**	96%	0,685714	12
19	0,393548	0,593548	0,793548	0,216	0,471429	0,671429	0,871429	0,092	**28**	100%	0,671429	14
20	0,432258	0,632258	0,832258	0,259	0,442857	0,642857	0,842857	0,101	**25**	89%	0,642857	20
21	0,451613	0,651613	0,851613	0,223	0,500000	0,700000	0,900000	0,107	**27**	96%	0,700000	7
22	0,445161	0,645161	0,845161	0,217	0,492857	0,692857	0,892857	0,107	**27**	96%	0,692857	10
23	0,438710	0,638710	0,838710	0,235	0,450000	0,650000	0,850000	0,107	**25**	89%	0,650000	17
24	0,367742	0,561290	0,761290	0,244	0,371429	0,571429	0,771429	0,122	**22**	79%	0,571429	29
25	0,458065	0,658065	0,858065	0,205	0,464286	0,664286	0,864286	0,107	**26**	93%	0,664286	15
26	0,438710	0,632258	0,832258	0,218	0,514286	0,714286	0,914286	0,104	**27**	96%	0,714286	5
27	0,445161	0,645161	0,845161	0,205	0,500000	0,700000	0,900000	0,107	**27**	96%	0,700000	7
28	0,380645	0,574194	0,774194	0,216	0,414286	0,614286	0,814286	0,119	**22**	79%	0,614286	24
29	0,438710	0,638710	0,838710	0,24	0,450000	0,650000	0,850000	0,139	**22**	79%	0,650000	19
30	0,419355	0,619355	0,819355	0,204	0,478571	0,678571	0,878571	0,113	**26**	93%	0,678571	13
31	0,445161	0,645161	0,845161	0,199	0,492857	0,692857	0,892857	0,115	**26**	93%	0,692857	10
32	0,400000	0,593548	0,793548	0,203	0,457143	0,657143	0,857143	0,112	**25**	89%	0,657143	16
33	0,361290	0,541935	0,741935	0,309	0,421429	0,621429	0,821429	0,089	**24**	86%	0,621429	23

Table 8. List of criteria ranked based on experts' opinion

Item number	Item	Fuzzy Evaluation	Score
6	Feasibility	0,764286	1
1	Accurate process description	0,750000	2
7	Input and Output data	0,735714	3
2	Aplications access	0,719048	4
4	Data security	0,714286	5
26	Rule based	0,714286	5
5	Efficiency	0,700000	7
27	Savings	0,700000	7
21	Process maturity	0,700000	7
22	Process standardize and stability	0,692857	10
31	Test data	0,692857	10
18	Process complexity	0,685714	12
30	Systems maturity	0,678571	13
19	Process cost	0,671429	14
25	Risk-proneness	0,664286	15
32	Time consuming	0,657143	16
23	Repetitive	0,650000	17
11	Number of exceptions	0,650000	17
29	SLA impact	0,650000	19
14	Number of systems involved	0,642857	20
20	Process Digitalization	0,642857	20
16	OCR involved	0,621429	22
33	Volume of items per transaction	0,621429	23
17	Predictability of outcomes	0,614286	24
28	Similarity between environments	0,614286	24
9	Manual involvement	0,607143	26
3	Automation type	0,585714	27
8	Labor intensity	0,585714	28
24	Reusability	0,571429	29
13	Number of robots that can run at the same time	0,571429	30
10	No cognitive ability	0,538095	31
15	Number of users	0,507143	32

Chapter 5: Demonstration and evaluation

This section will present the results of the evaluations performed on business processes from different organizations with the criteria list achieved in Section 4.

Based on Table 9, it was possible to perform multiple tests to observe if the ranked list of criteria would satisfy real cases. The ranking of the criteria list was done by three primary thresholds, if the value of *d* per item was below 0,2, if the percentage per item was higher tor equal to 75% and if the fuzzy evaluation value was higher than 0,5. Therefore, six tests were conducted with experts to rank business cases based on the new list of criteria. In each test, the organizations selected three business processes that could be already automated, in development or to be automated. In the initial phase of the test, the interviewee would give his opinion in which order they would automate the business processes based on their ranking system. Later the experts were asked to evaluate the business processes with values between 1 to 5 based on each criterion listed in Table 8. The experts did not know each criterion's factor values, presented in Table 9, so the evaluation was as unbiased as possible.

As seen in Table 9, the better classified an item was due to the Delphi method, the higher the factor it has. Therefore, the weight of each criterion was calculated by equation (5.1):

$$Score\ per\ item = expert\ value * factor \quad (5.1)$$

$$Factor\ value = \frac{(33 - Item\ position)}{100} \quad (5.2)$$

The equation (5.2) shows how the factor for each item in Table 9 was calculated.

Table 9. Factor values per item

Position	Item	Factor
1	Feasibility	0,32
2	Accurate process description	0,31
3	Input and Output data	0,3
4	Aplications access	0,29
5	Data security	0,28
6	Rule based	0,27
7	Efficiency	0,26
8	Savings	0,25
9	Process maturity	0,24
10	Process standardize and stability	0,23
11	Test data	0,22
12	Process complexity	0,21
13	Systems maturity	0,2
14	Process cost	0,19
15	Risk-proneness	0,18
16	Time consuming	0,17
17	Repetitive	0,16
18	Number of exceptions	0,15
19	SLA impact	0,14
20	Number of systems involved	0,13
21	Process Digitalization	0,12
22	OCR involved	0,11
23	Volume of items per transaction	0,1
24	Predictability of outcomes	0,09
25	Similarity between environments	0,08
26	Manual involvement	0,07
27	Automation type	0,06
28	Labor intensity	0,05
29	Reusability	0,04
30	Number of robots that can run at the same time	0,03
31	No cognitive ability	0,02
32	Number of users	0,01

The interview values were between 1 and 5. The highest this value meant that the criterion for that business process was very relevant, which would increase the final score for that business process.

For calculating the score per business process, it was necessary to calculate the average of all the scores per item. The score per business process was a value that only varied between 0 and 1. Closer to 1 would mean that the business process based on the list of criteria used was a good candidate for automation. In Table 20 it is presented the final evaluation of the six tests performed.

Table 20. Test result based on criteria list

Units of analysis	Order by which processes were implemented	Organizational processes assessed			Order advised by the artefact	Match with organization decision?
		Process 1	Process 2	Process 3		
1	1->2->3	0,65687	0,64656	0,53437	1->2->3	✓
2	1->2->3	0,69656	0,73562	0,69687	2->3->1	×
3	3->2->1	0,64812	0,70343	0,71437	3->2->1	✓
4	3->2->1	0,69093	0,69906	0,75281	3->2->1	✓
5	2->1->3	0,65375	0,73031	0,64468	2->1->3	✓
6	2->3->1	0,65968	0,68406	0,67218	2->3->1	✓

As shown in Table 20, from the six tests performed in 5 of the tests, the result order based on the list of criteria matches the same order as the expert would choose to automate the business processes.

Only in the second test the result between the expert order and the list of criteria did not match, resulting in an inconclusive test. In this case, the expert would typically use a small and fixed list of criteria. Only those criteria would matter for their evaluation. From this test, it was even possible to retrieve some feedback from the expert.

This feedback included some key points such as: know who will receive the output of the business process, the urgency of the automation, situations where the automation could potentially replace to be extinct departments and a more significant focus on the calculation of the savings.

Chapter 6: Conclusion

This study presents a criteria list that aims to help evaluate business processes suitable for automation. This research has two main contributions:

- Synthesize the knowledge that already exists in the literature. Such contribution was achieved by performing an SLR, resulting in a compilation set of criteria that served as a basis for the Delphi study.
- Create a set of criteria evaluated by RPA experts. This contribution was achieved by performing a Delphi study which resulted in a set of tuned criteria to produce the final artifact. The proposed artifact was then used to assess a set of processes from real organizations to understand if the result is aligned with workers' decisions.

The findings of this research are in line with the initial questions proposed for this study. This was demonstrated in Section 5 with the positive results obtained from evaluating business processes with the criteria list across multiple organizations.

The issues and limitations encountered in this research can serve as a basis for future developments in the subject matter. The first limitation regards the lack of literature currently available on the matter, which affects the fundamental research since the SLR is the basis for understanding the subject in study, which also affects the rest of the research. The second limitation regards the topic of RPA, in general, being a recent technology. Therefore, it is still challenging to identify people with a high level of expertise on the subject matter, which can cause a broader range of opinions while performing the Delphi study.

Even though the positive results were acquired in this study, there are still some aspects for evaluating business processes that were not considered. Therefore, as future work, the researchers will design a model based on the list of criteria obtained from this study as well as specific points of view given by the interviewees, which are essential to make more conscious decisions and have a more accurate way for evaluation of business processes that have good potential for automation. Furthermore, another future field of study is derived from the progress that RPA might have in the following years, which can acquire a higher level of intelligence from the software through machine learning and artificial intelligence, which can alter the way business processes are evaluated as well as the more significant amount of automation possibilities.

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